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Surgery, Gynecology and Obstetrics

WITH

International Abstract of Surgery

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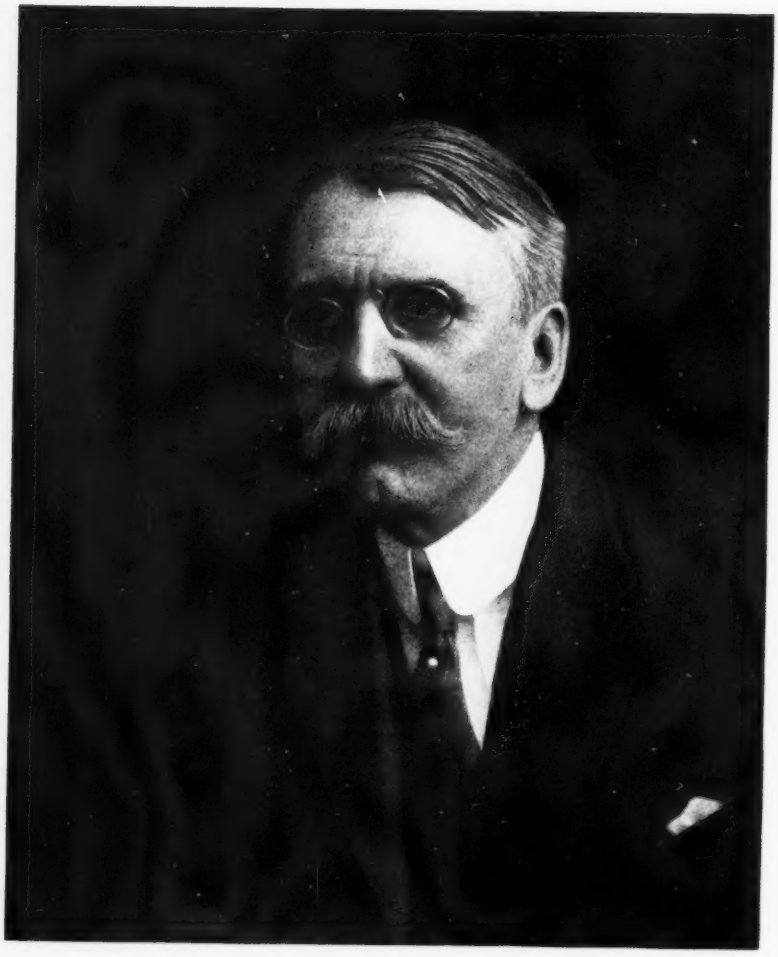

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SURGERY, GYNECOLOGY AND OBSTETRICS

AN INTERNATIONAL MAGAZINE, PUBLISHED MONTHLY

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SOME TECHNICAL POINTS IN ABDOMINAL SURGERY[1]

BY J. SCHOEMAKER, M.D., THE HAGUE, HOLLAND

BEFORE discussing technique in abdominal surgery, I should like to mention a few words regarding surgical technique in general. Operative surgery is not a sport, it is an art, and just as a violin player plays his sonata with his heart and soul, so the surgeon must perform his operation. This means that the artist does his work not in a hurry, not slowly, but *in tempo*, that he never goes to the next measure before the former is finished and well played, that he never makes a rest where it is not written, that he follows the prescriptions of the composer—for us, the laws of surgical science; but it also means that within these laws he is at liberty to do his work in his own way, striving for perfection and beauty, so that the finished product may be a work of art. But the surgeon is not a solo player; he is the first violin of a quartet, the other members of which are his assistant, his anæsthetist, and his operation nurse. These four must play together as one to produce the ideal result. For such co-operation it is necessary that they be so placed around the operating table that they can always look upon the field of operation—a very essential point—and that they always face each other. For this purpose I arrange my instrument table as shown in Figure 1, and when we are at work no one has to turn his back to the table—not for a moment; we are close together and face each other (Fig. 2).

And now let us go to the technique of abdominal surgery.

RESECTION OF COLON

Suppose that it is necessary for me to do a resection of the colon. The first great consideration is asepsis. We all know that the colon is full of germs and that it is impossible to make it quite empty. In addition, I wish if possible to do a simple operation; to remove the growth and suture the intestine end-to-end as is done in operating upon the small intestine. If no ileus is present, I should like to do the operation in one stage and leave the intestine in as nearly normal position as possible and so that there will follow no adhesions to the abdominal wall.

The only way to operate aseptically is to suture the gut with the lumen closed; the clamps must remain in place until the suture is complete. But to suture the gut properly I must see the three layers of it, for I want to sew them separately. The technique I use is as follows: After I free the tumor of its adhesions and ligate the mesocolon, I make a circular incision in the intestine through the serosa and the muscular layer but not through the submucosa and mucosa. I push the serosa and muscular layer with the knife to either side, thus making a tube of mucosa upon which I put my clamps. The clamps are placed close together and between the two the intestine is cut (Fig. 3). The clamps I use are very small; they are about the size of a Kocher artery forceps. I have not been successful in using the Kocher forceps for they always slip off unless I leave a fold of

[1] Read before the Clinical Congress of American College of Surgeons, Philadelphia, October 24-28, 1921.

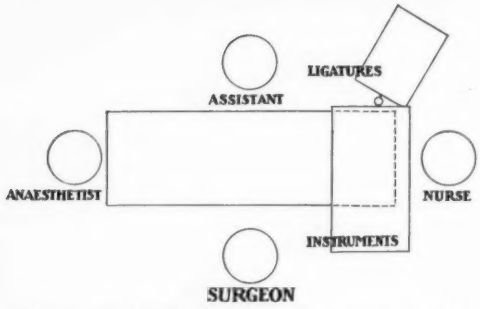

Fig. 1. Drawing showing location of operating table, surgeon, assistant, anæsthetist, nurse, and instrument table.

Fig. 2. Photograph showing same as Figure 1.

mucosa outside the blades, and this is just what I do not wish to do if I am to make an aseptic suture. Therefore, I have modified the forceps by making a deep slit in the blade, and in this slit the fold of mucosa is firmly held.

After the colon is cut at either side of the tumor the ends, which are closed by the clamps, are brought together to be sewed. I begin with the serosa at the back, as a rule using 6 interrupted sutures. Then I suture the mucosa and the border of the muscularis and serosa. I can see the three layers because I have already pushed aside the last two. The clamps are now turned around upon their axes and the suture through the three layers at the front is made over the blades of the clamps. The last stitch cannot be tied until the forceps are taken off. The forceps are removed by the assistant and just at the moment he releases them the knot is drawn tight

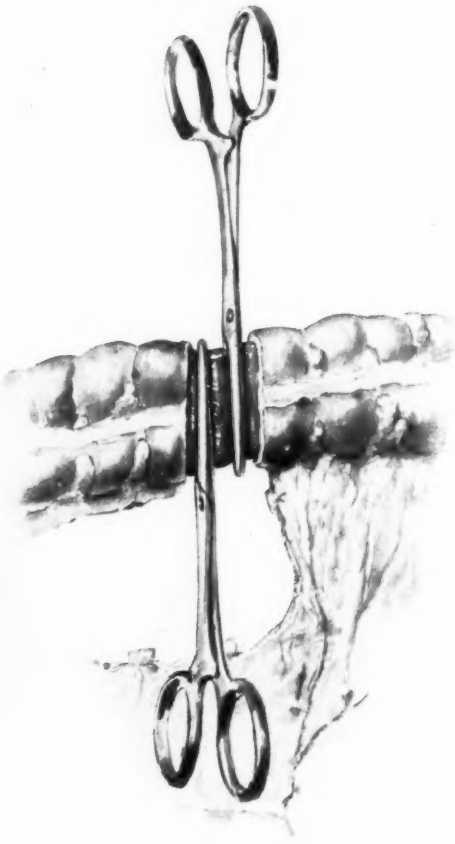

Fig. 3. Position of clamps in performing colectomy.

by the operator (Fig. 5). I suture the serosa with a continuous stitch, and the union of the intestine is complete. During the whole operation the lumen of the colon has not been opened and we have not seen or touched the inner side of the mucosa.

I have performed this operation 40 times for cancer of the colon with 3 deaths. It is remarkable that in these three cases the carcinoma had already extended beyond the intestine and had grown into the surrounding tissue.

I have used the clamps 179 times in removing the cæcum, the ascending colon, and a part of the transverse colon, in cases with pericolitis associated with obstipation. In this

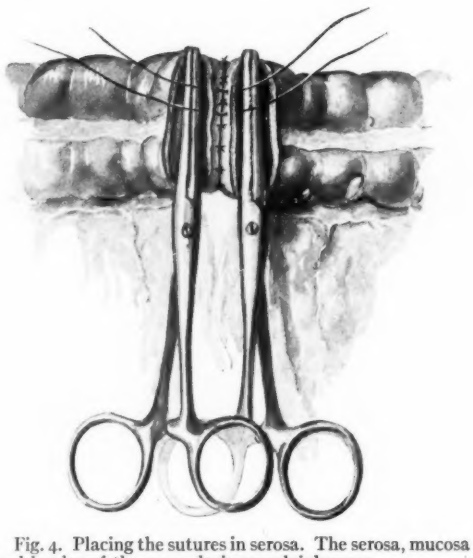

Fig. 4. Placing the sutures in serosa. The serosa, mucosa and border of the muscularis are plainly seen.

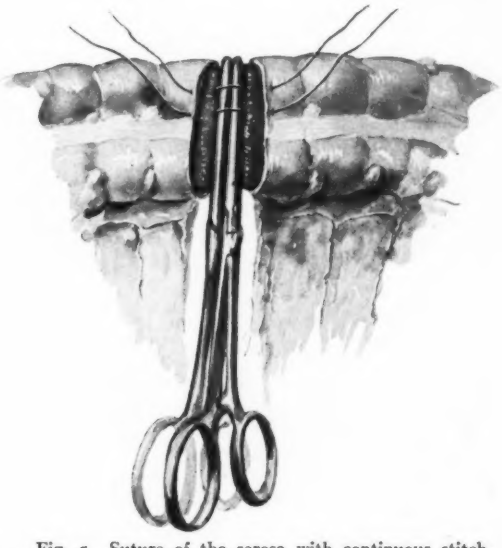

Fig. 5. Suture of the serosa with continuous stitch. Suture of intestine complete.

series I have lost but 2 cases; 1 from pneumonia and 1 from an embolus in an artery of the lung. In these cases I did not make a true colon suture but anastomosed the colon with the ileum. However, this is done in exactly the same manner—I always use the end-to-end suture. This is easily possible with the clamps because I stretch the small intestine perpendicularly to its long axis before I put the forceps on, and at the same time I compress the colon a little so that the one fits the other.

HEMISPHINCTERECTOMY

I use the same clamps in operating on the stomach. Here the same principles apply. We endeavor to do a simple operation and leave all the organs in as near normal position as possible. So you will readily understand that I am not a fervent advocate of gastroenterostomy nor of resection according to the Billroth II method. When I am convinced that a spasm of the pyloric sphincter is the cause of symptoms I do a hemisphincterectomy. This is one of the most simple operations one can imagine. The pylorus is grasped between the thumb and forefinger and an incision made in the serosa. The muscle is easily freed. It is cut near the greater curvature, pulled out with a forceps, and again cut near the lesser curvature. The serosa is closed with three or four stitches. This operation is not often indicated, but the few times I have performed it, it has given me full satisfaction (Fig. 6).

RESECTION OF STOMACH

When I do a resection of the stomach I always use the Billroth I method. It has been said that when a large part of the stomach is resected you cannot bring the stomach stump to the duodenum without producing great tension. I believe this is not true if the correct technique is followed. It is necessary to make the incision in the stomach as is shown in Figure 7. This incision has two advantages: first, it removes the part of the stomach which contains most of the lymph vessels; and second, the remaining part of the stomach forms a tube that is long enough so that it can be sutured to the duodenum without producing tension.

I operate as follows: I begin by freeing the duodenum, placing the ligatures on the vessels of the major and minor omentum, and then I apply one of my small clamps. I place a heavier clamp near the small one, for I want

Fig. 6. Technique of hemisphincterectomy.

to exert traction on it. Therefore I leave a strip of the stomach in front of the blades. I cut close to the smaller forceps. The mucosa of the stomach which is thus freed is not so liable to cause infection as is the mucosa of the colon. However, it is better not to let it touch the surrounding tissue or to handle it with the fingers. To avoid contact with the mucosa I put over the clamp a piece of metal which I call a protector. Now I raise the stomach from the abdomen and ligate both ligaments and the attachments, if necessary, at the back. If it is a case of cancer, I ligate the minor omentum as high up as possible; if it is a case of ulcer I ligate a few centimeters beyond the area of infiltration. On the greater curvature I go to the point where I figure the stomach tube must end. Here I apply my colon forceps at right angles to the border of the great curvature. Now I must place a clamp along the curved line which extends from the top of the forceps to the point of the lesser curvature, where I will begin the resection. The clamp I use is somewhat different from the common models, as will be seen from Figure 8. The clamp must serve two purposes: first, it must grasp the stomach so tightly that the stomach cannot slip when I cut it flush

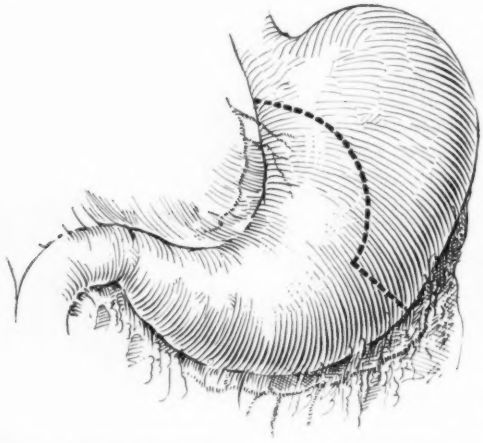

Fig. 7. Line of incision used by author in performing resection of the stomach.

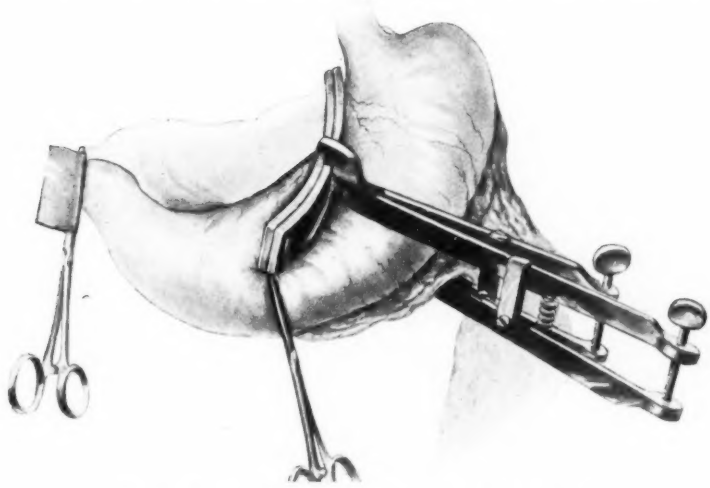

Fig. 8. Clamp used by author in resection of the stomach.

Fig. 9. Exterior part of clamp removed showing fine strip of serosa which is sutured with a continuous suture of catgut.

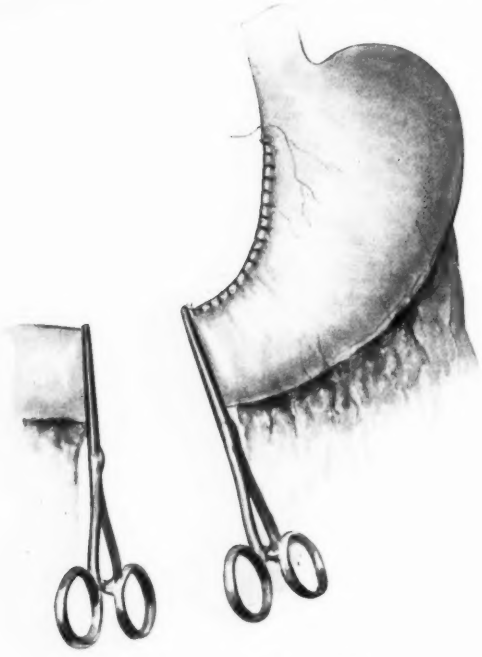

Fig. 10. The stomach tube completed.

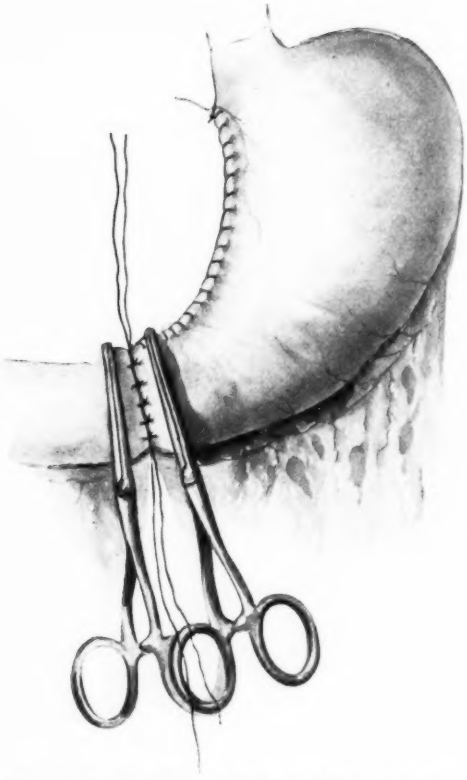

Fig. 11. Union between stomach and duodenum completed.

with the clamp; and, second, the clamp must be so made that it will expose a strip of serosa which I can suture before I remove the instrument. Therefore, the clamp must be heavy and strong and it must be in two parts.

I apply the special clamp and turn both screws very tight. Then, with one or two ordinary clamps, I isolate the part of the stomach that is to be excised and cut with a knife close to the special clamp and the colon forceps. Next I must suture along the curved line. I remove the exterior part of the clamp and this discloses a fine strip of serosa. A continuous catgut suture of the serosa is easily completed (Fig. 9), after which the other part of the special clamp is removed. Next I place over the catgut suture a continuous silk suture of the serosa, and this brings us to the point shown in Figure 10. The stomach tube is now complete and it remains to suture it to the duodenum. This is always easy. The distance from the cardiac end of the stomach to the duodenum in a straight line is less than the length of the tube when it is stretched (Fig. 11). Now I suture the serosa at the back, place an ordinary clamp on the stomach and one on the duodenum, and remove the colon forceps. A circular catgut suture through the three layers and suture of the serosa in front complete the operation.

If the point at which the three sutures meet seems weak, a flap of serosa from the stomach can easily be placed over it and fixed by a single stitch to the duodenum. But this point seldom gives trouble. I have not used the screw clamp often enough as yet to show statistics, but I have done resections many times following the Billroth I method with other clamps, and I am happy to state that I have lost no patient due to leakage of the suture.

FELLOWSHIP ADDRESS[1]

By SIR HAROLD J. STILES, K.B.E., Edinburgh, Scotland

Regius Professor of Clinical Surgery, University of Edinburgh; President of the Association of Surgeons of Great Britain and Ireland

AMERICA has already been more than generous in making me an Honorary Member of the American Medical Association and of her three chief surgical associations. To occupy a place on the roll of Honorary Fellows of the College of Surgeons of America is an honor of which I am intensely and genuinely proud, and it is one which I and my descendants will treasure for all time as a crowning reward for my surgical endeavors, although I am only too conscious that the honor is out of all proportion to my very humble achievements: rather do I regard it as a gracious compliment to the famous University to which I have the honor to belong, and as a generous recognition of the great traditions of the Surgical School from which I have descended. I am particularly proud that the honor you have just conferred on me should have been received in the city of Philadelphia, the birthplace not only of the oldest medical school in the United States but also of the one which I believe has more Edinburgh blood in its veins than can be traced in the pedigree even of Columbia and Harvard.

The War of the Revolution was the making of Morgan and Shippen, two of the greatest pioneer surgeons of the eighteenth century, both Philadelphians and both Edinburgh graduates. Physick, who was Professor of Surgery in the University of Philadelphia in the early part of last century, and who has often been spoken of as the father of American surgery, was also educated in Edinburgh. Then, again, we have Samuel Gross, said by some to be the father of modern American surgery. He played the same rôle in Philadelphia that Syme did in Edinburgh. They had much in common: both were good anatomists and pathologists as well as great surgeons: both were great diagnosticians and great teachers, and both had the art of inspiring and of winning the affection of their pupils. Although Gross was not an Edinburgh graduate he visited Edinburgh when Syme and Simpson were at the height of their fame.

Gross has always occupied a warm place in my heart particularly on account of his admiration for Sir Astley Cooper. Dr. Finney, in one of his admirable addresses, says: "Teachers in medical schools should not only instruct their pupils but should instill into them by precept and example the right spirit toward their profession and the right attitude toward their patients," and this Sir Astley Cooper surely did. My grandfather, who lived to the age of 96, wrote of his great master, Cooper: "It would be an act of ingratitude did I omit to pay a tribute of respect to the memory of my distinguished anatomical and surgical teacher, Sir Astley Cooper. He did not owe his distinction to exalted rank or to privileges attached to high birth, but rose by the honorable exertion of his native energies, and ultimately attained the most exalted preeminence; indeed, became one of the most illustrious surgeons that ever adorned the science he professed. To Sir Astley Cooper I am indebted, more than to any other man that ever lived, not only for the greater share of anatomical and surgical knowledge I possess but for the privilege of witnessing in him the enthusiasm which filled his soul with an ardor and love of his profession, which incited in me a noble emulation to imitate his praiseworthy example. He stimulated me to exertion—stimulated me in the acquirement of knowledge." Incidentally, I may say that it was through the references in my grandfather's autobiography to Sir Astley Cooper that I myself became fired with the ambition to become a surgeon.

Gross, in this autobiography, said: "I learned my first lessons in surgery from Sir Astley Cooper's Lectures, reprinted in Philadelphia soon after I began the study of medicine. Every student should read them, for they abound in good sense and sound practical knowledge." The same remark

[1] Presented before the convocation of American College of Surgeons, Philadelphia, October 28, 1921.

would apply to Syme's *Principles of Surgery*. On visiting St. Paul's Cathedral, Gross expressed his delight at seeing there a statue to Sir Astley, but took the occasion to deplore the absence of similar memorials in America to inspire our youth with ambition—a grievance which the American Surgical Association so wisely and generously removed after the death of Gross by erecting in Washington a statue to his memory. Syme, Lister, Gross, Keene, Murphy, and many others have had the same inspiring influence as Cooper over their pupils.

The Edinburgh School of Surgery, to which you have paid a tribute in honoring one of its teachers, dates back to 1505, when the Town Council granted the Corporation of Surgeons and Barbers permission to dissect the body of one condemned man in the year. The English Company of Barber-Surgeons did not receive their charter until 35 years later.

The oldest minute-book in the possession of the College of Surgeons contains, on its first page, a prayer by the famous Scottish reformer, John Knox, and, if you will allow me, I will quote it, as it has since been read by the Secretary at the opening of every meeting of the College: "O eternal God, and our loving and mercifull Father in Christ Jesus, seeing we are conveenit heir to treat upon these things that concernis our calling, we beseik thee, O Lord, to be mercifull to us, and giff us grace to proceid thereintill without malice grudge or partialitie; sua that the things we may do may tend to the glorie of God, the weill of our vocation, and confort of every member of the samen; throw Jesus Christ, our only Lord and Saviour; Amen."

The next step in the evolution of the Edinburgh School consisted in the creation of the Museum of the College, which is one of the finest collections in Europe. In 1703, the Incorporation of Surgeons erected an anatomical theater, and, two years later, Robert Eliot was appointed first professor of anatomy in the Town's College, which had received its charter from James VI in 1582.

John Monro, a Fellow of the College of Surgeons, whose ambition it was to found a Medical School in Edinburgh, sent his son, Alexander, to study Anatomy and Surgery in London, Paris, and Leyden. In 1720, Alexander Monro was appointed to the chair of anatomy: a few years later, 1725, he transferred his teaching to the University, and the following year saw the establishment of a Medical Faculty.

Of Alexander Monro, primus, it can truly be said that he was "the father of the Edinburgh Medical School," and, although he was more anatomist than surgeon, Edinburgh surgery owes him an everlasting debt of gratitude for being the moving spirit, along with Lord Provost Drummond, in founding the Royal Infirmary, which soon developed into one of the most famous schools of clinical teaching in the world.

Previous to the establishment of a Faculty of Medicine in the University of Edinburgh, anatomy had been taught by private lecturers belonging to the Incorporation of Surgeons. These men were really the pioneers of the Edinburgh Extramural School.

What is now known as the Old Royal Infirmary, where Lizars, Fergusson, Liston, Syme, and Lister did their epoch-making work, was opened in 1741. It contained 228 beds, and a single operating-theater accommodating 200 students.

Before 1833, when Syme became professor of clinical surgery in the University, the Edinburgh School of Surgery was rendered famous by Benjamin Bell, whose six-volume *System of Surgery* was translated into French and German, and by the brothers John and Charles Bell, both great surgeon-anatomists. The latter was also an epoch-making physiologist, his discovery of the functions of the spinal nerve roots entitling him to rank second only to Harvey. Charles Bell migrated to London, to return to Edinburgh later as professor of systematic surgery. While in London, he taught anatomy at the well-known Great Windmill Street School, where he accumulated a number of valuable specimens, now in the Museum of the College of Surgeons of Edinburgh. Both he and his brother John were endowed with great artistic talent, and the water-color drawings of Sir Charles Bell, of gunshot

wounds, the result of his experience at Waterloo, are classical.

The fame of the Edinburgh School of Surgery in the first half of the last century was largely due to the surgeon-anatomists of the Extramural School. Principal Sir Alexander Grant, in his historical volume entitled *The Story of the University*, gives full credit to the important rôle played by the extramural lecturers in the evolution of the Edinburgh Medical School, and remarks that "one of its greatest advantages has been that the University has continued to be surrounded by extramural rivals who have kept its professors up to the mark and sometimes eclipsed them, and who have always been in training to fill up the ranks of the University whenever vacancies occurred." My colleague, Mr. Miles, in his admirable little book on *The Edinburgh School of Surgery before Lister*, makes the further observation that "In another direction, the extramural teachers have played an important part in guiding the destinies of the medical school. Free from the bonds of statutes and ordinances, they have always been able to lead the way into developing instruction in special branches of knowledge, and many of the specialists that are now represented within the University originated in the Extramural School."

The Chair of Clinical Surgery which I have now the honor to occupy was founded by George III, in 1803. The first occupant was James Russell, who enjoyed the intimate friendship of Sir Walter Scott. On his resignation, Liston and Syme contested the vacancy. The latter was appointed, and became the greatest teacher of his generation. He died in 1870, shortly after his son-in-law, the immortal Lister, who succeeded him, had initiated the new era in surgery. A few years later, Liston accepted the Chair of Clinical Surgery at University College Hospital, London.

Robert Liston was perhaps the most famous of all the anatomical surgeons in the Edinburgh School. Before he was appointed to the staff of the Edinburgh Royal Infirmary, he was performing, with the assistance of Syme, operations more formidable than those which were undertaken in the Infirmary. He is well known to us all as the introducer of the transfixion method of amputation, and as being the surgeon who performed the first major operation in London under ether, in 1846. The operation was an amputation through the thigh. There was a dispute between the time-keepers as to whether it took 25 or 28 seconds to remove the limb. The patient was in the operating-theater only 5 minutes. Liston's remark as the patient was leaving the theater was "This Yankee dodge, gentlemen, beats mesmerism hollow."

Lizars, who was appointed Professor of Surgery in the College of Surgeons of Edinburgh in 1831, is well known in America as being the first surgeon in Great Britain to perform the operation of ovariotomy, which had been introduced by your own countryman, MacDowell. MacDowell had sent a copy of his first paper to his old teacher, John Bell, of Edinburgh, who was then ending his days in Italy. The paper came into the hands of Lizars, who was also a pupil of Bell's.

Of all my predecessors, however, the immortal Lister stands out pre-eminent, and I refer to him with the deepest humility, as I am only too conscious of my inability to maintain the great traditions which he created in the Edinburgh School. The Very Rev. Dr. Wallace Williamson, dean of the Thistle, and minister of the historic Cathedral of St. Giles in Edinburgh, which most of you have no doubt visited, has contributed to the history of medicine a most beautiful and life-like piece of word-portraiture of Lister, and I rejoice to think that it will become immortalized by Garrison in his splendid work on the *History of Medicine*, a volume of immeasurable educational value and one which should occupy a foremost place in the library of every member of our profession. He says: "Of Joseph Lister's winsome personality, those speak most warmly who knew him best. It was his gentleness, above all, that made him great. His very presence was a spiritual force. Clear-eyed and pure of soul, he cherished from earliest days that love of truth which guided him to the end.

His noble passion for humanity extinguished all thoughts of self and personal fame, impelling him along that path which he steadfastly pursued till he found the greatest secret of his search, and bestowed on the world probably the greatest boon which science has been able to win for the physical life of mankind. Yet greater than his greatest achievement was the man himself, and the final secret of his greatness was that serene simplicity which was his most distinguished characteristic. His was the grave and thoughtful courtesy which bespoke the Christian gentleman and the earnest lover of his kind. Hence we are not surprised to learn how he stirred enthusiasm and moved men to reverence, how he gained such love and affection as rarely falls to a scientific teacher. Behind his acknowledged mastery of his science, his grave and noble face, marked by soft lines of tranquil thought, revealed a soul of singular beauty and sweetness, of high integrity and stainless honor. That such a man, dowered with God's gift of genius, should rise to the lofty heights and achieve great things was inevitable."[1]

Although the last century saw the end of the purely anatomical era of surgery, I have no hesitation in bringing into the foreground the prominent part which the great surgeon-anatomists of my school have taken in the evolution of surgery. The medical curriculum is now so overcrowded that the medical student, while he may be more spoon-fed with anatomical details, does not acquire the same dissecting-room knowledge of anatomy that was possessed by the student of my day. The dissecting-room is the surgeon-probationer's basic laboratory. My advice to all my house-surgeons who wish to take up surgery as their life-work is to go back to the dissecting-room and teach practical anatomy for at least one year. This is not only good for himself, for surgery, and for his patients, but it is an advantage also to the dissecting-room, as it supplies it with demonstrators who can appreciate and point out the bearing of anatomical details and topographical relations on the practice of surgery.

[1] Rev. Wallace Williamson. Brit. M. J., 1912, i, 444.

It has been said that a weak point in the training of the young American surgeon of the present generation is his deficient knowledge of morbid anatomy and morbid histology, and that he too often feels the need of a pathologist at his elbow in the operating-theater. Personally, I am always grateful that early in my career I devoted time to the study of surgical pathology. For two years following my house-surgeonship I was a whole-time demonstrator of anatomy, and for the succeeding 9 years, during which I taught surgical anatomy, I had charge of the pathological laboratory in connection with the chair of systematic surgery then occupied by Professor Chiene. In this capacity it was my duty to give demonstrations in surgical pathology to his class and to examine and report upon all material derived from his wards. The surgeon of today cannot be regarded as fully trained unless he himself is pathologist enough to be able to assess the significance of the naked-eye and histological appearances of the tissues and organs with which he has to deal.

The last half-century has created a new epoch characterized by an ever closer alliance between the basic sciences of physics and chemistry with physiology and pathology, and the closer application of all of them to the practice of surgery. The chief pioneers of this new era were Kocher and Horsley, and for the present stage of its evolution we are indebted to the brilliant researches of such men as Cushing, Carrel, Crile, and to Plummer, Kendall, and Rosenow of the Mayo Clinic—in short, to the American School of Surgery.

The problem before surgeons today is: "How is this more scientific and enlightened conception of surgery to be encouraged and promoted?" The question is of the greatest importance from the academic point of view. In the first place we must not merely rearrange the time-table of the curriculum, but we must also reform and co-ordinate the teaching in such a manner that the student may be shown how to apply his knowledge of the basic sciences to the investigation and treatment of disease—in other words, to his clinical work.

In Edinburgh, in addition to the professorship of chemistry, we have a chair of chemistry in its relation to medicine, and the same applies to the teaching of physics to the medical students. With regard to botany and zoology, these subjects must of necessity be taught in the Faculty of Science as separate sciences. It is to be hoped, however, that in the near future, the medical student will be given a combined course of animal and vegetable biology, and that the syllabus will be drawn up on such broad and fundamental lines as to ensure that the course will provide him with the best possible foundation for his future studies. It is quite possible that the ideal professor for such a purpose does not exist, and that he will require to be created and specially trained for the purpose. It is a man of the type of the late Professor Huxley that is wanted.

It is to be hoped that the teaching of physics and chemistry in the secondary schools will soon reach such a high standard that these subjects may be relegated to the University entrance examination; otherwise the medical curriculum will have to be still further extended.

Edinburgh now as in years past holds the record for undergraduate medical education. While her machinery is specially constructed for this purpose, her 1,800 medical students seriously handicap her in providing facilities for postgraduate clinical work.

It is lack of funds which is sadly crippling us in respect of facilities for original research, and unless the money is forthcoming for the Institute we hope to erect as a memorial to Lister, and for which we are at present making an appeal, I am afraid Edinburgh will not be able to pull her full weight. The existing University laboratories are already heavily taxed with the work necessary to keep up the high standard of undergraduate teaching.

The constitution of the American College of Surgeons shows that the best surgeons of America intend to translate their ideals, their vast energies, their intellect and wisdom into terms of united action for the good both of the guild and of the community. The destiny of the College is in the hands of men who are known throughout the surgical world, men who have traveled and made themselves familiar with the organization of the ancient surgical corporations and surgical schools of Europe. Your College starts with a clean slate, unhampered by tradition. True, you have undertaken a gigantic task, such as only Americans would have the courage to venture upon, but when I read the names of the Governors and Regents, I am confident their efforts will be crowned with success. No one can sign the pledge of your College without a sense of responsibility being aroused within him. I feel sure, however, that every honest and conscientious surgeon must admit that, in signing it, he is pledging himself to do no more than is his duty to himself, to his profession, and to the community.

A point which especially arrested my attention on reading the by-laws was the emphasis placed on "interchange of opinion" and "attendance on the important societies and clinics." Surgeons of the individualistic type, who are contented with confining themselves to the knowledge gained by their own exclusive experience, can reach only a certain standard of efficiency, and, while it must be admitted that a few reach a high standard, it is safe to say they have done so in spite of their self-sufficiency and not because of it. That they would have ranked still higher in the surgical world had they been willing to learn from others, everyone will I think admit.

Perhaps the most striking clause in the laws of the College is the admission to your Fellowship without examination. This departure from precedent was not only justifiable, but, under the circumstances, necessary. Experienced examiners on my own side of the Atlantic have for long felt that the admission of candidates to our Fellowship by the methods of examination at present in vogue is open to serious criticism. It by no means follows that, because the candidate has passed the examination, he is competent to perform major operations. It is to be hoped that the bold, enlightened, and sagacious step which your College has taken will encourage our own colleges to take further and possibly similar precautions to see that

candidates who obtain the Edinburgh Fellowship are worthy of the distinction. Whether your College obtains sufficient evidence that your successful candidate possesses an adequate knowledge of anatomy and pathology is the only criticism I would venture with regard to your present system.

The first impression one might gain after reading the Constitution and By-laws of the American College of Surgeons is that they have been framed in such a way that the governing body is vested with an authority and disciplinary powers which might be said to interfere somewhat with the liberty of the subject. Even if we admit a certain amount of truth in this impression, it must be remembered that the profession has a duty both individually and collectively, not only to its own members but also to the community which it serves. It may safely be asserted that in no walk of life, in no other profession, and in no other branch of our profession is the life of the subject so much at the mercy of his fellow-man as when he places himself in the hands of the surgeon. It is only right and proper, therefore, that the profession itself should see to it that such a sacred trust, and such a powerful weapon for good or evil, should be placed in the hands of men who have shown that they are morally as well as intellectually and technically capable of fulfilling the trust. In America, these powers have been vested in a Council of Regents and an Executive consisting of men of the highest integrity, of great experience, and of powerful intellect—men who combine great foresight and sagacity with sound judgment, men who can think as able administrators as well as function as great surgeons. Such combined effort is calculated to secure a fine and accurate adjustment of the activities and functions of the surgical profession.

It was the War—a war of science—which brought very forcibly before us what may be accomplished by properly combined and co-ordinated effort fortified by authority and discipline. The peace which has followed has created the opportunity and the necessity for breaking away from tradition, for readjustment, and for reconstruction. The phenomenal progress which surgery has made during the present generation and the added knowledge gained through the War has made it all the more imperative that surgery should set its house in order. The surgical world is grateful to America that she has taken the initiative in combining and co-ordinating her surgical forces with the object of raising the general standard of surgery not only in its academic centers but in the hospitals throughout the States. What is needed is co-operative thought transformed into co-operative action. These basic aims have evidently been in the minds of those who drew up the constitution and by-laws of your College. By vesting the general management of your corporation in a Board of fifty Governors who shall select fifteen of their number, along with the President for the year, to form a Board of Regents in whom shall be vested the details of management, and by choosing from the Board of Regents an Executive Committee consisting of the President, the Secretary, the Treasurer, and five other Regents, the College has created a powerful "thought-organization" capable of originating and carrying out an enlightened and far-reaching policy.

The molding and developing of hospitals, their better equipment, and the improvement of the standard of work done in them are some of the most important pieces of organization and propaganda work that your College could undertake. By placing your expert knowledge and experience at the service of the American Hospital Association, you secure a unity of thought and purpose which cannot fail to have great influence upon public opinion and ensure the co-operation and sympathy of the municipal authorities as well as open the purse-strings of the well-to-do citizens. It is important that the lay public be made to see that, after all, the hospital is the surgeon's schoolroom, and, the better it is equipped, the better will be the training of the surgeon and the better the treatment of the citizen.

The systems of hospital organization in Great Britain and America differ very materially. In my own country, all the large teaching hospitals—indeed, the large hospitals generally—are supported almost entirely

by voluntary contributions, so that each hospital has its own organization and method of administration. There is no attempt at combined effort with a view to standardization, and little has been done to encourage architects to specialize in hospital construction or to create a body of expert hospital superintendents.

Our own hospital system has recently been the subject of a Parlimentary inquiry. The Committee has reported in favor of a continuance of the voluntary system, but it is doubtful how long this system will survive under the present burden of taxation. The municipal authorities will certainly be against the placing of our large hospitals on the rates. While our hospital system is excellent from the point of view of the working classes, it does not meet the requirements of the middle-class population in the way that your system here does. The American system, however, may I venture to suggest, has two defects which I feel sure the American College of Surgeons will be able to remedy without calling in the aid of the State, or I should say without the interference of the State. I refer, firstly, to the rotation system of a three or four months' service of general practitioners on the staff of the surgical side of hospitals; and, secondly, to the system whereby facilities are given to practitioners of little or no surgical experience, for operating on their private patients in public or semi-public hospitals. These two customs may in great measure be responsible not only for the relatively large amount of surgery done by general practitioners in America but also for a tendency to the commercialization of surgery.

In my own country, we are inclined to go to the other extreme. The want of proper hospital accommodation for our middle classes sometimes compels us to operate on patients in their own homes or in imperfectly equipped nursing institutions. While it may occasionally be necessary for a good surgeon to operate under unfavorable conditions, his conscience ought to dictate that he should only give the patient his second-best when it is impossible to do otherwise.

Specialization in surgery should not be discouraged provided it is preceded by a good general training in surgery. It encourages intensive work in those with special aptitudes: the work itself is better done, and an added zest for it is created. A fine adjustment of task to individual aptitude is an economy of effort and applies not only to modern surgery but to modern education generally.

I think I am correct in stating that it is just forty years since the Harvard Medical School instituted a Department of Orthopedic Surgery, and I am sure my American confrères will be surprised to hear that no such department exists in the Edinburgh Royal Infirmary. Thanks to the genius and magnetic influence of Sir Robert Jones, assisted by a band of orthopedic experts from America, this branch of surgery did outstanding work during the War, indeed, it furnished perhaps the best illustration of what may be achieved by able generalship, good organization, and team-work.

It is to be hoped that the lesson to be learned from the orthopedic experience and achievements during the War will bear fruit, and that, by the establishment and proper equipment of an orthopedic department in our teaching centers, the standard of the surgery of the extremities will rapidly improve. We envy America her public-spirited citizens who subscribe with such open-handed generosity to every kind of educational institution. The Edinburgh Royal Infirmary, with its 900 beds, is an imperial institution from the point of view of medical education. It draws its patients not only from Edinburgh and district but also from a large part of Scotland as well as from the north of England. The Board of Management has recently issued an appeal for £250,000 without which it will be impossible for it to maintain its traditionally prominent place in the advancement and teaching of medical sciences. So far, the appeal has brought in only about £40,000. Unfortunately, Scotland is a small and relatively poor country, with no millionaires, and I am sorry to say the chairman of the finance committee, who is fully alive to the necessity of establishing an orthopedic department in our great hospital, tells me that it cannot be done—unless some Scots-

man who has amassed wealth overseas can be persuaded to come to the rescue.

Already America has done splendid work in establishing a proper system of preserving and cataloguing case-records. It is only in this way that a reliable analysis and review of the immediate and remote results of operations can from time to time be obtained. If the College of Surgeons can help to establish a definite and more standardized follow-up system, such as exists in Boston, Rochester, Baltimore, Cleveland, and elsewhere, statistics of real value will be obtained.

Your College affords great possibilities also in the way of assessing the real value of various methods of treatment which are at present in a more or less experimental stage. Think, for example, of the benefit which would accrue from a well organized collective investigation into the value of radium and X-rays in the treatment of malignant disease. With the machinery for organization which your College possesses, the untold wealth of material at its disposal, and the reliable observations which could be guaranteed, I am convinced that in this line of investigation, America could head the world.

Surgery and science generally are ever becoming more and more international. America has taken more advantage of this cosmopolitan spirit than we Britishers, and in my judgment, this is the main reason why the scepter of surgery is today wielded by America.

British surgeons, I feel confident, rejoice that you have taken Canada into partnership with you in founding your College. The next step, I trust, will be a closer alliance with British surgery. I am thankful to say that at last we have formed an Association of Surgeons of Great Britain and Ireland, having the same ideals and aims as the American Surgical Association, and it is to be hoped that these two bodies will form the beginning of an intimate English-speaking surgical brotherhood. Science, and especially medical science, recognizes no frontiers: it is the most powerful agent we possess for welding together our two nations—a union which would go far to ensure the peace, the happiness, and the prosperity of the world.

I cannot do better than conclude with the words used by Sir Berkeley Moynihan, an Honorary Fellow of your College, who, as you all know, is as well as a great surgeon an inspiring writer: In presenting you with the mace I see before me, he said, "We pray God may regard it as a symbol of our union in the harsh days of trial, as a pledge of unfaltering and unchanging hope that the members of our profession in the two lands shall be joined in brotherhood forever in the service of mankind."

OLD METHODS VERSUS NEW IN SURGICAL DIAGNOSIS[1]

By JOHN B. DEAVER, M.D., F.A.C.S., Philadelphia

IT is with a deep sense of privilege coupled with no less a sense of obligation that I assume the high office to which you have been pleased to elect me. Not the least of its privileges is that of extending a word of welcome and greeting to our colleagues from far and near who have come to grace these meetings with their presence, and to extend the hand of fellowship to those chosen to be received in our ranks. Not the least of its obligations is that of maintaining the high standards set by my distinguished predecessors in office. With your co-operation and encouragement, I hope I may wear the mantle of office which has just fallen upon my shoulders as gracefully and as effectively as they have done.

High standard in surgery is the primary reason for the existence of this organization. In formulating these standards, it is well to bear in mind that the new is not always the best, nor is youth always wiser than age. Huxley has well said that none of us, not even the youngest among us, is infallible. Men of experience have seen method after method heralded as a panacea, lauded to the skies, only to fall in disuse and be consigned to a well deserved oblivion, because it has failed to stand the acid test of experience. I hesitate to express my fear that this may prove to be the ultimate fate of radium treatment for cancer; for I should greatly regret to see our fervent hopes rudely shattered. But at least I feel justified in sounding a note of warning against too great expectations, for we have already found that it falls far short of being a universal cure and, indeed, in many situations where we most need help, it has proved sadly lacking. In the progress and development of medicine there have arisen allied branches both in medicine and in surgery, too numerous for any one man to dare hope to make his own. The result is the specialist in practical and in theoretical work. And even the specialties are divided and subdivided into almost numberless branches. So that in the last half century or more there has been a great transformation in surgical and medical practice. These sister sciences, while they have added to the joys of practice have also increased the responsibilities of the profession.

If the impression of one who has seen the new order displacing the old is worth consideration, if observation of methods formerly relied upon as contrasted with those now particularly stressed may call forth reflection as to their utility in the actual hand to hand combat with disease and death, I may perhaps be permitted to say that in this process of transformation there seems to lie a danger of underestimating the value of the old and tried methods of clinical diagnosis by sight, touch, and hearing, and of regarding these as less scientific than something that is gained through the medium of a piece of apparatus, or by a reaction in a test tube. The exactness of a scientific method does not mean that its results may be applied to diagnosis, prognosis, or treatment with the same mathematical accuracy. The deductions from such a method may be hazardous in the extreme if applied to clinical purposes. As an example of such an error we may mention the attempt to base the indication for operation in appendicitis upon a rising leucocyte count. This was gross clinical ignorance, and ignorance can never be scientific. All data, however, must be submitted to interpretation before judgment can emerge, and data gained directly by questioning and by the older methods of examination have exactly the same scientific status as those secured by indirect methods. Moreover, up to the present time their value greatly predominates in assessing the individual case and conditions. We must see to it therefore that while the boundaries of knowledge are being extended and while we are placing new tools in the hands of the younger generation, the older arts which are the chief reliance of the diagnostician must receive proper emphasis.

With the advent of each new decade in the dramatic progress of surgery within the last

[1] President's address Clinical Congress of American College of Surgeons, Philadelphia, October 24, 1921.

half or three-quarters of a century it seemed as though the limits of improvement in diagnostic and operative procedure had been reached. But no sooner was one new avenue of endeavor opened than the pathway became ever wider and wider. No sooner did we have the boon of general anæsthesia than we were enriched with the means of producing local anæsthesia, which has become an indispensable part of every operating theater. Hardly were we in possession of Pasteur's and Lister's epoch-making discoveries than we found ourselves in the midst of the new science of bacteriology and its sister branches, and of surgical pathology studied on the living subject. And then came the era of active experimental research, which with rapid strides has added so much to our knowledge of certain phenomena. With the advent of the world war came the opportunity of applying to large numbers of cases the numerous theories developed during the years of patient work in the research laboratories of chemistry, physiology, and pathology, while the exigencies of the hour brought forth brilliant measures which made it seem as though our surgeons had, indeed, been endowed with the wand of magic. The varied program offered for our meetings during the coming week, holds out the prospect of having in store much valuable information on the very interesting results of war surgery. Indeed, a glance at the diverse subjects to be handled and demonstrated would justify the assumption that finality in surgery had at last been reached, for there is now practically no region of the human body that is closed to the aseptic scalpel of the surgeon. I think, however, I may venture to say that we who are daily at work at the operating table and in the sick room, know full well the limitations of our science and our practice and the lack of finality in the art in which we, "looking for the high white star of Truth," aspire to become masters, and the mastery of which today is beset with much greater difficulty than at any former time.

The future of surgery and of surgical research doubtless belongs to America, and on the American College of Surgeons rests the responsibility of fulfilling the promise which that future holds out.

In conclusion, I can only hope that the work of the present Congress will be fruitful of results and that when it comes to a close there will have been something permanent added to our knowledge and that we will have gained renewed courage and inspiration to carry on for our common purpose: To bring healing to the nations and promote the welfare of mankind.

MASSIVE HYPERTROPHY OF THE BREAST[1]

By LINWOOD D. KEYSER, M.D., Rochester, Minnesota
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INTRODUCTION

ANOMALIES of the breast have always attracted a peculiar interest, every degree and type of developmental error having been described in both male and female. Possibly because of their relative frequency or because they might offer some clue to the reason for normal physiological development, hypertrophic disorders of the mammary gland have been studied more closely than other pathological conditions of this type.

A certain degree of excessive enlargement of the breast is within physiological limits, as for example, the prominent breasts seen not infrequently in young matrons and much oftener in parous women after the menopause. Such hypertrophies can hardly be considered pathological and are usually concomitant features with an obese habitus. Rarely, however, the bounds of physiological development are broken and the breasts attain such proportions as to become a nuisance to their possessor, either because of their unsightly appearance or because of the encumbrance imposed by the mere burden of their weight. In extreme cases life itself may become impossible unless surgical intervention is undertaken.

Writers who have mentioned such cases have often left some doubt with regard to the true pathology of the condition. Their meager descriptions might apply equally to large tumors or to true mammary hypertrophy. Hence little reliance can be placed on earlier medical literature. Probably the first case of established authenticity is that described by Durston in 1669. This case presents remarkable features. It is claimed that the entire process of hypertrophy took place within the space of one night. The weight of the left breast was 64 pounds, that of the right 40 pounds, a total weight of 104 pounds, so far as I know, the greatest on record. It is probable, however, that either the patient or the physician may have been mistaken with regard to the time of development.

Labarraque, in 1875, was the first to consider the subject of mammary hypertrophy in a scientific manner. Five years later Billroth reported several cases and made some important observations on the pathology of the condition, giving it the name "diffuse true mammary hypertrophy." Kirchheim, in 1902, collected 31 cases, reported in detail a case of his own, and discussed the possible etiological factors. Johnston, in 1903, reported a case, and gave an excellent pathological description of the amputated breasts by Bloodgood. Guthrie and Albert, in 1916, reported several cases of which excellent pathological studies had been made. Deaver and MacFarland, in their remarkable monograph on the breast, tabulated the chief features of 240 cases which they collected from all sources, some being of admitted questionable authenticity.

FACTORS AFFECTING MAMMARY DEVELOPMENT AND FUNCTION

In a study of excessive mammary hypertrophy, it may be of value to consider briefly a few of the main facts concerning normal mammary development and function, and some of the more tenable hypotheses that have been advanced in explanation.

The mammary gland seems to be a modified group of sudoriparous glands (Keibel and Mall). On the ventral surface of the 9 millimeter embryo is a thickening of the epidermal cells, known as the "milk ridge." From this ridge, by downward growth of epithelial columns, which form at first papillary and later bulb-shaped anlagen, the breast develops. Secondary bud-like extrusions of the epithelium from the terminal portions of the bulbs, piling up of the corium cells to form a nipple, and absence of development of hair follicles in the pigmented areolar zone serve

[1] This work was done in the Section on Surgical Pathology, Mayo Clinic.

to complete the picture of the embryonic mamma. At birth the gland consists of a nipple on whose surface from fifteen to twenty lactiferous ducts empty, each corresponding to a column of epithelial cells which has been slightly hollowed out by a central process of cornification. These columns divide dichotomously, and from the terminal radicles bulb-like extrusions, the primitive acini, arise.

Shortly after birth in both sexes, there are signs of mammary activity. This is associated with phenomena such as swelling, redness, and the secretion of so-called "witches milk." When this period of activity is over it is found that the epithelial columns are no longer solid but have become tubular throughout. Hence it is possible that the symptoms associated with these changes may be due to the expression of the central core of cornified epithelium in the mammary columns. The female breast shows, at this time, its first evidence of differentiation from that of the male; the number of branchings of the tubules and the total amount of parenchyma in the former are markedly increased.

From infancy to puberty the breast undergoes few changes; the tubules, however, become gradually more numerous, especially in females. The attainment of sexual maturity brings changes in both sexes but these are of greater magnitude in the female. There is an increase in the size and number of the parenchyma cells, more frequent branching of the tubules, and a corresponding increase in the amount of adipose tissue which definitely divides the parenchyma into lobes. Occasionally secretory activities are apparent, but this is somewhat unusual. The changes which occur in the male breast are relatively insignificant so that at maturity a few tubular elements with a slight amount of subcutaneous fat comprise the entire male mamma. Rarely the male breast may simulate the female breast in type of development, giving rise to a condition known as "gynecomastia." This process is frequently associated with other sex anomalies and is rarely excessive; this is hardly within the scope of the subject under discussion. Gravidity and lactation again bring further increase in the size and probably in the number of epithelial cells. Pocket-like alveolar outgrowths from the branching tubules become dilated, thus giving rise to true mammary acini. There is a relative diminution of the adipose tissue at this time. The acini appear to be lined with a single layer of columnar cells and it is difficult to distinguish the membrana propria as a separate entity. During lactation the acini and its lining cells become distended with an albuminous fatty fluid, the milk.

The factors which control the development and functioning of the breast are almost certainly of the order of hormones and are in close relationship to the organs of reproduction. The older theories of a nervous control have been forever put aside by the conclusive nerve sectioning experiments of Goltz and Ewald and of Pfister and Eckhard, as well as by the even more significant mammary transplantations of Ribbert. From the clinical standpoint it is found that normal puberty hypertrophy and ovulation begin at approximately the same period; that cretinism and hypopituitarism, especially that of the Froehlich type, are likely to be associated with mammary hypoplasia; that hyposexual development (such as infantile uteri, and small ovaries) are likely to be associated with undeveloped breasts, that precocious sexual maturity will probably be accompanied by early puberty hypertrophy, and finally that after the establishment of the menses signs of mammary activity may develop at each catamenia, fullness, swelling, tension, sometimes pain, and rarely secretion having been observed. A great deal of experimental work has been accomplished but it may be said that this has served to confuse as much as to clarify the problem. Castration of young animals before puberty prevents normal mammary development, which, however, may be brought about after such an operation by a transplantation of one of the removed ovaries. Hammond and Marshall have demonstrated, experimentally, that hysterectomy alone, the ovaries being retained, has no influence in preventing puberty hypertrophy. This would seem to rule out the uterus from consideration. Loeb and Hesselberg claim to have established the fact that there is a definite cycle of mammary activity in guinea pigs

which runs parallel in some degree at least with that of heat and ovulation. They believe, further, that they have shown the corpus luteum to be a prominent if not the chief factor in both puberty and pregnancy hypertrophy. The causes which bring about the changes of the breast in gravidity and lactation are even more obscure. The decidua (Loeb and Hesselberg), the fœtus (Lane-Claypon and Starling), the placenta (Halban, Basch), and the corpus luteum (Ancel and Bouin, Loeb and Hesselberg), have all been given the chief rôle as mammary activator, but the experimental evidence is conflicting and inconclusive, as Frank and Unger have emphasized. Clinically it is known that the corpus luteum is excessively enlarged during pregnancy and that there is often a disturbance of lactation on the return of the menses; both of these features point to an ovarian control of mammary activity. In contradistinction to this is the fact that castration after pregnancy begins does not prevent but rather prolongs lactation. The hypothesis might also be advanced that the return of ovulation tends to bring about a return of the breast to its former resting condition and that an absence of this stimulus is associated with a delay in this regressive process. The degree of mammary hypertrophy during lactation seems to be in no way related to the total amount of milk secreted. Another clinical feature of note is that at the menopause cessation of ovulation and menstruation is accompanied by atrophic changes in the parenchyma of the breast and also as a rule by an increase in the fatty tissue. Finally it has been established that pituitary (posterior lobe) extract acts as an efficient galactogogue during the period of lactation but whether this is a direct or an indirect influence is not clear.

Although knowledge of the physiology of the function of the mammary gland is incomplete and problematic, nevertheless facts as follows are presented as being approximately correct:

1. The mammary gland is under the control of endocrine forces.

2. The occasional instances in which psychical factors seem to play a part, illustrated by the unusual cases of elderly women or young children who have been known to lactate on having an infant placed at the breast, may be explained theoretically by indirect influence on the internal secretory system.

3. Puberty hypertrophy is almost certainly dependent on ovarian activity.

4. There is a definite cycle of mammary activity running somewhat parallel to the menstrual cycle.

5. There is suggestive evidence that the corpus luteum by its formation, persistence, or regression may influence the normal cycle of activity of the breast in pregnant as well as nonpregnant states.

6. No good evidence has been adduced that the uterus, decidua, fœtus, or placenta have any direct bearing on the function of the breast.

CLINICAL FEATURES OF MASSIVE HYPERTROPHY OF THE BREAST, REVIEW OF CASE REPORTS

In attempting to show the manner in which massive mammary hypertrophy deviates from normal physiological development, a review of the clinical information to be gained from case reports is of value. The usual patient is one who shortly before or after the first catamenia begins to notice an enlargement of her breasts. At first this may attract little attention and is thought to be the physiological development normal to this time of life. Soon, however, the excessive increase in size becomes a matter of concern and a source of great embarrassment to the patient and to her family. The course of the process from this time on is variable. There may be no further enlargement, or the breasts may progressively increase in size, reach even to the knee and weigh as much as 60 pounds. All intermediate degrees of hypertrophy have been reported.

Age. The age at onset in one-half of the bilateral cases was under 18. The greater number of patients come under observation at 16 years. The youngest patient mentioned was 12, the duration of the growth having been one year (Firket). The oldest patient was 48, the duration having been 16 years (Ehrenhaus). In 120 cases in which the age at onset is given, or can be inferred with

approximate correctness, the following is found:

Twenty-eight patients were under 15 years of age.

Fifty-nine patients were from 15 to 20 years. Fifty-four were virgins; three were pregnant; details were not mentioned in two.

Twenty-four patients were from 20 to 30 years; nine were pregnant or parous; six had not been pregnant; details were not given in nine.

Eight patients were from 30 to 40 years; three were pregnant or parous; details were not mentioned in five.

One patient was between 40 and 50 years. No details were given.

Race and climate. Racial and climatic factors apparently have no bearing on the etiology. American, English, French, German, Italian, Chinese, Negro, Hindu, and other races are mentioned.

Heredity. Heredity is mentioned as a possible factor in three instances. Pflanz reported the case of a married woman, aged 30, whose mother had suffered at one time with great enlargement of the breasts and whose brother was gynecomastic. Englander reports a case of an adult woman with enlarged breasts, whose mother had had a right breast twice the size of the left. Caubet reports the case of a girl 12½ years, with massive hypertrophy of the breast. Her mother had had the same condition at the same age, but subsequently the breasts had returned to normal size. The daughter, however, required an operation to relieve her of the cachexia which threatened her life. These cases indicate that heredity may be a factor, but not often enough to be of much value etiologically.

The side affected. The side affected is mentioned in 182 cases: the process was bilateral in 142 and unilateral in 40. In twenty-five of the unilateral cases, the left breast was involved seventeen times, the right eight times.

Duration of the process. The duration of the process is extremely variable. Aside from Durston's improbable report, the shortest period of massive growth is in Zurakow's patient, a pregnant woman of 22 whose breasts attained large proportions in the short space of 2½ months. The average duration of growth in young pregnant women has been about 10 months. The average period for all patients under 21, virgin, married, or pregnant, is 20 months, while the average for all patients over 21 is 5 years. The shortest period of growth in patients under 21 is 2 months, while the longest period is 4 years. In women over 21 the shortest period is 2½ months and the longest 16 years.

Size. The largest breasts recorded are those of Durston's patient (heretofore recorded). Porter's case with a left breast of 43 pounds and a right breast of 17 pounds is probably the next. The majority of the patients had breasts of from 7 to 10 pounds. As the border between physiological and pathological hypertrophy is not easily defined, no sharp line of demarcation between the two can be drawn.

Secretory activity. The secretory activity of the mammary gland in massive hypertrophy is extremely variable. There is no relation between the degree of hypertrophy and the amount of secretion. Freund had a patient with a tremendous pregnancy hypertrophy who failed to lactate, while Zurakoff and Benoit and Monteils report instances in which lactation was absent in parous women whose hypertrophy had taken place before they became pregnant. On the other hand cases in which lactation followed the massive hypertrophy of pregnancy are cited by Anthony and Warren, Esterle, Gibson, Ramsbotham, Rosinski, Speth, and Van Swieten. Ehrenhaus had an unusual case of hypertrophy in a non-pregnant multipara, who secreted as much as a quart of milk a day. In the cases seen in the Mayo Clinic abnormal secretory activity has not been observed. However, it should be noted that in Case 3 the patient had nursed her child after the onset of the hypertrophy which began with pregnancy.

Pain. Pain of varying degree was present in about nineteen cases. True pain is not to be confused with the discomfort and fatigue so frequently brought about by the ponderous mass of the breasts alone. In our four cases pain was a prominent feature; from the beginning in Case 4. It was entirely absent in Cases 1 and 3, and was insignificant in Case 2.

Clinical course of growth, influence of menses, pregnancy, lactation, spontaneous regression. The rate of growth of the enlarging breasts varies markedly. It may progress uniformly or intermittently. The relation of the hypertrophic process to menstruation, pregnancy, and lactation, conditions under which ovarian activity undoubtedly reaches a high degree, may be noted. The hypertrophy frequently commences immediately before or after the establishment of menstruation. In the case of Schoal the patient never menstruated, while in our Case 2 menstruation was always meager and ceased entirely after the breasts were amputated. Sometimes menstruation seems to act as a stimulus to growth. Thus Ferrus reports the case of a Spanish girl whose breasts progressively enlarged with each successive period. On the other hand the establishment of a normal menstrual cycle may be associated with a diminution in size of the hypertrophic breasts and possibly with a return to normal (Lane, Benoit and Monteils). Pregnancy and lactation likewise have an inconstant influence. Thus the breasts may become greatly enlarged during successive pregnancies, to diminish in size after lactation (Speth, Van Swieten, Monod, Anthony and Warren, and Cerutti). Freund's remarkable patient with an enormous gravidity hypertrophy failed to lactate, but on the fourteenth day of her puerperium both breasts began markedly to diminish in size. Jorden, Esterle, and Ramsbotham cite further instances in which excessive hypertrophy during pregnancy was followed by a return to normal after lactation. Ramsbotham's case was that of unilateral hypertrophy.

Spontaneous diminution in size unassociated with pregnancy is also known to occur. Hey, Hoy, Schield, Le Double, and Terrill report cases in which the removal of one breast was followed after a variable length of time by diminution in the other. Labarraque, Shield, Zurakow, and Velpeau had patients who noticeably improved under treatment by compression and iodides given internally, while Delfiz reported one case which he cured with inunctions of mercury hydroiodate. Thompson had a patient whose breasts had returned to normal size 3 years after she first came under observation. Billroth had a similar case. Kirchheim, in his case of virginal hypertrophy, tried a partial resection with a plastic operation on one side, but the unresected portion of the one breast and the entire gland on the other side continued to grow to such an extent that total bilateral ablation had to be performed.

Thus it is seen what a variable and uncertain course this pathological process may take. Forces which stimulate growth in some cases have just the opposite effect in others and cause the appearance of regressive changes.

Association with sex anomalies and pathological conditions of the reproductive organs. Several authors have mentioned the occurrence of sexual anomalies or disease of the reproductive organs in association with massive hypertrophies, such as patients suffering from scanty menses or total absence of the menstrual function. Our Case 2 is an example. Foges, Warren, and Herczel had patients with massive hypertrophy and supernumerary mammæ, which were also affected by this process of overgrowth. Bryant's patient had a bifid uterus and other sexual abnormalities. Bartel's patient had an infantile uterus, and very small ovaries; Kirchheim's patient presented much the same features, the ovaries being extremely painful. Grah's patient, aged 14, suffered from ovarian disease. Week operated on a woman of 42 for uterine disease. Her breasts, which had been greatly hypertrophied, immediately began to diminish in size. From these instances it appears that the association of massive hyertrophy with some form of abnormal condition in the genital organs is not infrequent and in taking the history of each case a searching inquiry should be made with this association in mind.

CLASSIFICATION OF MASSIVE HYPERTROPHIES OF THE BREAST: PATHOLOGICAL CONDITION

There should be a sharp distinction between true mammary hypertrophy and those excessive enlargements which are due to the presence of tumors, such as intracanalicular myxoma or fibroma, lipoma, sarcoma, and so forth. Pathological hypertrophy is a condition in which the normally differentiated tissue ele-

ments of the glands singly or severally undergo enlargement and hyperplasia which is diffuse throughout the entire organ. Thus Durston, speaking of the breasts in his patient, said that nothing was found but "prodigious bigness." However, there are slight variations in type of tissue of overgrowth which call for a grouping of these cases in certain general classes. The tendency has been to classify such enlargements by some name which designates the time of life or the conditions under which they have occurred. Thus the names "infantile hypertrophy," "diffuse virginal hypertrophy," "gravidity hypertrophy," and "hypertrophy in parous women unassociated with pregnancy" give the necessary implication.

Most of the pathological reports have been consistent in certain features: Flattening of the nipple is almost always present and may account for the frequent interference with secretory activity in the puerperium as the infant is likely to find difficulty in suckling. Thickening of the skin, hypertrophy, fibrosis, diffuse fibro-epithelial tumor associated with fibro-adenomata are also prominent terms in the usual description. Porter described the condition in his case as diffuse intracanalicular fibro-adenoma. Adiposity is rare; only four cases have been described. When present it seems to be diffuse and is usually the predominant tissue element, as in our Cases 2 and 4. Malignancy in these breasts is certainly unusual, although Billroth reports a patient who developed a sarcoma, and Bloodgood mentions the occurrence of carcinoma and of sarcoma under such circumstances. Kirchheim describes the breasts in his case as consisting of hypertrophied glandular and fibrous elements through which fatty tissue was distributed in intimate relationship to the parenchyma. Bloodgood's report of the pathological condition in Johnston's cases mentions hypertrophied skin, fibrous hyperplasia with a moderate diffuse epithelial proliferation, encapsulated fibro-adenomata, atrophy of the subcutaneous fat, and general sparseness of fat elsewhere, as the predominant features. Some of his photomicrographs seem to show the activity of the tissue reserve cells (textoblasts) of the outer layer of the acinar epithelium, a process which has been found prominent in the cases in the Mayo Clinic. The interstices of the fibrous tissue were filled with a serum-like fluid in our Case 1. Succulence of the fibrous tissue has been frequently mentioned in other cases and was present to a moderate degree in this case.

A review of the cases described in the literature, and of the four cases in the Mayo Clinic has led to the conclusion that from the standpoint of pathological physiology, massive hypertrophies of the breast are probably all different manifestations of an anomalous endocrine process and that a classification based on the time of life or the parous state is likely to be misleading. Case 1 which is of the diffuse virginal type, and Case 3, which is a typical gravidity hypertrophy of long duration, present essentially the same histological pictures. Likewise Case 2, a virgin patient, and Case 4, a parous patient with the hypertrophy unassociated with pregnancy, have breasts which would be difficult to distinguish grossly or microscopically. Pathologically these cases may be classified in two groups, fibro-epithelial hypertrophy, frequently associated with fibro-adenoma, and adipose hypertrophy, in which fatty tissue composes the bulk of the massive breast. The latter condition is extremely rare according to Guthrie and Albert, who were able to find only three cases besides their own; these were the cases of Robert and Ammesat, of Warren, and of Beatson. My own study of the literature has failed to bring further evidence of the occurrence of the massive adipose hypertrophy, so that our Cases 2 and 4 are probably the fifth and sixth to go on record. However, it is likely that in certain cases both the fatty and fibrous tissues may be hypertrophied. For instance, Kirchheim states that in the breasts of his patient were islands of fat in intimate relationship to the parenchyma with which they were surrounded. But even here he remarks on the general diminution of fatty tissue in the breasts, and a general tendency for either the fibro-epithelial tissue, or the fatty tissue to be excessive, the former far more frequently than the latter. In either type of hypertrophy the presence of gravidity

or lactation may or may not superimpose the histological picture normally associated with that period.

The pathological data in the cases in the Mayo Clinic are given in detail in the histories of the cases. Summaries of the important features are as follows: In Case 1 a fibro-epithelial type of hypertrophy is associated with multiple fibro-adenomata and small retention cysts. Absence of fat, succulence of the preponderant fibrous tissue, regenerative changes in the acinar epithelium (primary cytoplasia of MacCarty), and rapid proliferative changes in the fibrous tissue of the adenomata are found. Case 3 is almost identical. It is a fibro-epithelial type which began with pregnancy. There is a tendency to a grouping of the acini into lobules, and the breaking up of these lobules by the invasion of differentiating, and differentiated fibrous tissue can be traced through different stages, as if the fibrous tissue had grown to such an extent as to choke the acini and bring about their obliteration. Cases 2 and 4 are of the adipose type. The patient in the former was a girl of 19, and in the latter a woman of 42, whose breasts had hypertrophied 12 years after a pregnancy. The grouping of the acini is broken up and fat is the preponderant element, the meager fibrous tissue being disposed of in radiating bands which carry a moderate number of acini whose basal layer of tissue reserve cells (textoblasts) shows signs of slight reproductive activity. The epithelial cells in all of the cases are hypertrophied to a variable degree.

CONSIDERATION OF POSSIBLE ETIOLOGICAL FACTORS

Trauma was mentioned in the case of Velpeau but was not considered to have any bearing on the etiology. While the greatest number of cases occur about the time of puberty and adolescence, there are so many exceptions to this rule as to make it certain that this time of life is not essential to the development of the condition. The histological picture in no way suggests a true neoplasm, as the process is diffuse and seems to affect all portions of an entire organ simultaneously and uniformly.

It would seem more probable that massive hypertrophy depends for its cause on some dyscrasia of the endocrine system. Our knowledge from clinical and experimental sources leaves little doubt but that the normal growth of the breast is related to the sex organs, and is strongly suggestive that the ovary is the controlling factor in mammary development. Massive hypertrophy occurs for the most part in association with puberty and pregnancy, when the equilibrium of the internal secretory organs is probably temporarily upset to be re-established on a different basis. Under such circumstances it is possible that certain endocrine forces which stimulate the growth of fibrous and epithelial tissue may come into play, or more rarely adipose tissue. The fibro-epithelial type suggests in histology an overactivity of some endocrine organ while the adipose type might well be related to a hypofunction of the ovary, thyroid, pituitary, or adrenal cortex, singly or combined. Thus the association of the fatty breasts with menstrual irregularities in Case 2 and similar cases mentioned by Guthrie and Albert, suggest an abnormality of ovarian or pituitary type, although other features often associated with dyscrasias of these organs are lacking.

Against the theory of an endocrine etiology must be cited the rare cases of unilateral hypertrophy. These are indeed difficult to explain but the weight of their evidence is counterbalanced by the instances mentioned in which in addition to the hypertrophy of the true breasts there was a simultaneous massive enlargement of supernumerary glands. In short it may be said that in the light of clinical and experimental evidence there are strong reasons for believing that a dysovarianism is the probable cause of this anomaly. However, further development of the physiology and chemistry of the body hormones must be awaited before this point can be considered settled.

DIAGNOSIS

As a rule the diagnosis offers little difficulty. Intracanalicular myxoma and fibroma, lipoma, sarcoma, elephantiasis, and the fatty breasts of general obesity are to be differentiated. The diffuse nature of the process, the

bilateral enormous enlargement, the uniformity of the growth, which is usually relatively rapid, the absence of pain, and the frequent association with puberty and pregnancy are, in the majority of cases, sufficient to make the diagnosis clear. The distinction between the adipose type and the fibro-epithelial type may be difficult. The former occurs much less frequently than the latter, and the breasts are, as a rule, soft, in the adipose type, while the fibro-epithelial overgrowth is usually associated with an increase in the firmness of the gland. This feature may be further accentuated in certain localized areas by the presence of fibro-adenomata. Elephantiasis occurs rarely, the few cases on record having been reported chiefly from Samoan and Russian sources (Deaver and MacFarland). It seems to occur for the most part in young women and may simulate very closely fibro-epithelial hypertrophy. Other features of elephantiasis may assist in the differentiation. In any event there is no practical loss since the treatment of the two processes is essentially the same.

TREATMENT

The tendency of the breasts to undergo spontaneous regression in some cases leaves doubt with regard to the efficacy of various methods of treatment which have been employed on empiric grounds. Iodides, administered as inunctions and internally, local pressure, and various "applications" have been tried, but the number of cases in which they are claimed to have been successful modes of treatment is too small to allow definite conclusions. A conservative and practical plan is to wait for a length of time consistent with the health and mental composure of the patient in the hope that the enlarged breasts will decrease in size. If time fails to ameliorate the condition and the patient is desirous of being rid of her affliction, which is often as much mental as physical, then amputation seems to be indicated. While the operation deprives the patient of her mammary function it is hardly to be considered mutilating and has no evil sequelæ. Opotherapy, on the basis of an endocrine etiology, while theoretically possible, is neither rational nor feasible at the present time, although it is to be hoped that the future development of this field of medicine will lead to a new and more satisfactory method of treating this rare but most unpleasant condition.

REPORTS OF CASES

CASE 1. (A349418.) M. P., a girl of 15, was admitted to the Mayo Clinic, February 12, 1921, complaining of enlargement of both breasts. The family history and past history were irrelevant. Her menses had started during the previous year and were perfectly regular in time, duration, and amount of flow. About one year before she had noticed that her breasts were becoming larger. There had been steady progression in growth until at the time of her examination she was troubled with the inconvenience and burden of the weight. She had received X-ray treatment and internal medication.

At the time of examination the girl measured 5 feet, 3.5 inches in height, and weighed 122 pounds. Before the onset of the mammary enlargement she had weighed 100 pounds. Both breasts were greatly enlarged and hung to the level of the umbilicus. On palpation they were found "lumpy" in consistency. Aside from a trace of albumin and an occasional pus cell in the urine the remainder of the examination was negative.

Operation was performed February 17, 1921 (Pemberton), a simple amputation of the left breast being done. February 23, 1921, the same operator removed the right breast. The postoperative course was not remarkable and the patient was discharged in excellent condition March 10, 1921, with wounds entirely healed.

Pathologist's report. The left breast weighed 4200 grams in the fresh state; the skin was tense and slightly hypertrophied and the nipple flattened. There was no dermatitis. The areola was not discolored. On section a pearly white slightly succulent mass of fibrous tissue was found through which were scattered punctate translucent areas corresponding to mammary acini. The fibro-epithelial tissue was arranged as multiple circumscribed and encapsulated fibro-adenomata, and as diffuse white areas between the adenomata. The largest of the adenomata was about 5 centimeters by 9 centimeters and the smallest 1 centimeter; they contained parenchyma units more closely grouped and in greater number than in other areas. In the nipple zone the radiating lactiferous ducts stand out poorly, the interstitial areas having been filled with fibrous tissue to such an extent that the normal anatomy was greatly distorted. There were a number of small cysts, most of them grouped in the upper outer quadrant, and comprising structures ranging from minute dilated acini to definite cystic areas 5 millimeters in diameter and filled with a thin clear fluid. Possibly the most striking feature was the absence of fat. None was found in the

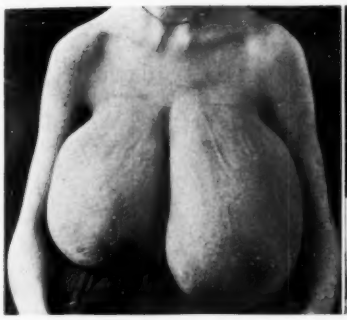

Fig. 1.

Fig. 2.

Fig. 3.

Fig. 1. Case 1. Fibro-epithelial type of massive hypertrophy. Girl aged 15.

Fig. 2. Case 1. Patient shown in Figure 1, 2 weeks after operation.

Fig. 3. Case 1. Cross section of right breast showing fibro-epithelial type of hypertrophy associated with fibro-adenomata. The macroscopic picture closely resembles that of the growth in Case 3.

mass of the breast or beneath the skin. Only a few patches of adipose tissue were seen toward the periphery and base. Microscopic sections from the fibro-adenomata showed the stroma to be about ten times as abundant as the parenchyma and to consist of loosely placed growing fibrous tissue in the process of differentiation. The stroma cells were mostly spindle-shaped with a faintly eosinophilic cytoplasm and oval or elliptical nuclei which take a light basophilic stain. There was a diffuse stippling of the nucleus with chromatin particles and in some cells small though definite nucleoli, single or double. No mitotic figures were observed. In some instances the cell differentiation was not so complete, the contour being more circular than ellipsoid, the nucleus larger and staining more faintly, and the nucleoli more prominent. Cell polarity was maintained fairly well, the axes of the spindles being parallel in most places. An occasional small lymphocyte and a few plasma cells were noted. Only a few capillaries traversed the field. The epithelial elements were arranged in acinous form, some being circular and others irregular in contour; some were cystic and dilated, some elongated. The irregularity of the acini seemed to be due to the crowding in of fibrous tissue rather than to the reduplication and piling up of layers of cells. The adenoma as a whole was circumscribed and encapsulated; its surface was covered by the two-layered mammary epithelium, a condition which suggested that the whole mass had protruded itself into a canaliculus and might well account for the fact that the process has been described by some authors as "diffuse intracanalicular fibro-adenoma." The individual acini were lined with two layers of epithelium presenting a striking illustration of cell hypertrophy and of the regenerative process described by MacCarty as primary cytoplasia. Thus the inner layer consists of large cuboidal cells completely differentiated, that is having perfect polarity, strongly basophilic cytoplasm and karyoplasm, and granular nuclei and nucleoli which are not prominent. The elements composing the outer layer were of the nature of tissue reserve cells (textoblasts). In addition to extreme hypertrophy these cells showed morphological signs of reproduction and were still in the process of differentiation. The cytoplasm was hydrophic and even vesicular in some instances; the nucleus was large and stained lightly; the nuclear granulations were finer and in a few cells a small nucleolus was seen. There was no cellular migration or breaking through of the so-called "basement membrane" at any point. Many acini contained a slightly eosinophilic fluid. This was probably of the same nature as the material found in the cysts.

Sections from the diffuse fibro-epithelial areas not associated with fibro-adenomata showed the stroma to be hundreds of times more abundant than the parenchyma. The fibrous tissue was highly differentiated and markedly eosinophilic, being loosely arranged with small interstices between the bundles. In some areas the fibers had taken on a wavy appearance. The nuclei dotting the field were typical of normal fibrous tissue, that is, spindle-shaped, markedly basophilic, and small. Occasional lymphocytes were found but there was nothing to suggest an inflammatory reaction. The sparse parenchyma units in certain areas again consisted of acini with an inner layer of normal differentiated cells (textocytes) and an outer layer of tissue reserve cells (textoblasts) showing all degrees of hypertrophy and variable signs of reproductive activity. There was a variation also in the size of the acini in such areas of the breast. In the acini with marked cystic dilatation the textoblasts of the outer layer was very inactive and all the cells lining the cysts were of the flattened cuboidal type.

The right breast weighed 2500 grams and was essentially the same type of structure as the left breast except that it contained only one adenoma

Fig. 4. Fig. 5. Fig. 6.

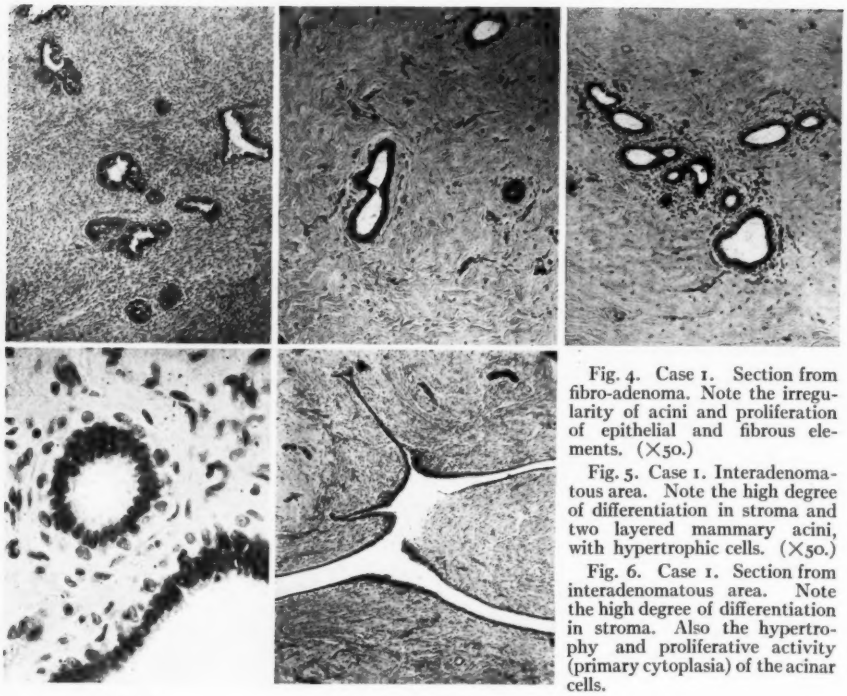

Fig. 4. Case 1. Section from fibro-adenoma. Note the irregularity of acini and proliferation of epithelial and fibrous elements. (×50.)

Fig. 5. Case 1. Interadenomatous area. Note the high degree of differentiation in stroma and two layered mammary acini, with hypertrophic cells. (×50.)

Fig. 6. Case 1. Section from interadenomatous area. Note the high degree of differentiation in stroma. Also the hypertrophy and proliferative activity (primary cytoplasia) of the acinar cells.

Fig. 7. Fig. 8.

Fig. 7. Case 1. Acinus from such a field as Figure 6. Note the huge cells in both acinar layers. The outer cells (textoblasts) are in the process of differentiation. (×500.)

Fig. 8. Case 1. Showing the intracanalicular tendency of the growth in certain areas.

2.5 centimeters by 3 centimeters. This adenoma occurred near the nipple zone where the radiating ducts stood out more clearly than in the specimen from the left side. The same histological features were found as in the left breast.

A pathological diagnosis was made of bilateral massive hypertrophy of the breast, fibro-epithelial in type and associated with multiple fibro-adenomata and numerous small cysts (Figs. 1 to 8).

Case 2. (A242930.) M. S., a girl aged 19, came to the Clinic August 8, 1918, complaining of enlarged breasts. The family history and past history were unimportant. Menstruation had begun at the age of 14. Periods were regular but lasted only one-half day, the amount being very small, with severe pain during this time. The breasts began to increase in size just before puberty and had been growing progressively larger. There had been no pain but the appearance of the enlarged breasts had been a source of mortification.

Examination showed a well developed girl, weighing 178 pounds, normal weight being about 150 pounds. She had mild tonsillitis and dental caries. The breasts were very large and pendulous, hanging nearly to the umbilicus. The enlargement seemed to be diffuse and no nodules or circumscribed tumors were palpated. The patient was advised to return home and wait, in the hope that the breasts might undergo spontaneous regressive changes.

April 13, 1920, the patient returned to the Clinic stating that for the past 2 months she had been suffering greatly with shooting pains in both breasts, chiefly in the upper outer quadrant. The breasts themselves had remained stationary in size, and had not shown any changes associated with the menses which had continued scanty and painful.

Examination revealed essentially the same condition. The patient insisted on operation and in consequence a simple amputation of both breasts was performed April 21, 1920 (Hedblom). The postoperative course was uneventful, and the patient was discharged in good condition May 5, 1920. She was heard from again in April, 1921

Fig. 9.

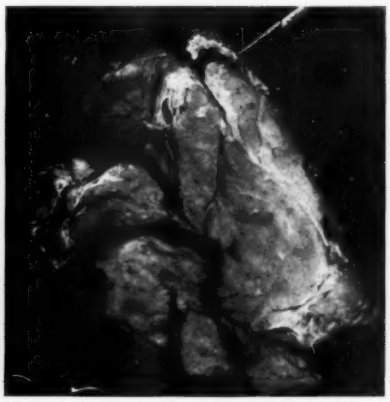

Fig. 10.

Fig. 11.

Fig. 9. Case 2. Adipose type of massive mammary hypertrophy. Girl aged 19.

Fig. 10. Case 2. Cross section through breast showing preponderant adipose tissue streaked with fibro-epithelial strands.

Fig. 11. Case 2. Photomicrograph of typical area of fat traversed by fibrous tissue band containing elongated acini. This picture is almost identical with areas from Case 4. (×50.)

She had not menstruated since the operation and had complained of frequent attacks of indigestion accompanied by vomiting. Her weight was 175 pounds.

Pathologist's report. The right breast weighed 2000 grams. The skin was slightly thickened and the nipple flattened. The mass of the breast was made up of fat which was divided into a number of lobules by septa of fibrous tissue variable in size and frequently confluent. The parenchyma was sparse in amount and distribution; it was limited entirely to the fibrous tissue, none being found in the fat itself. The nipple zone also was invaded by the adipose overgrowth and the normal anatomy was obliterated. Microscopic sections showed adipose tissue traversed by bands of highly differentiated eosinophilic fibrous tissue. There was a total absence of acini from the fat; a few occurred as elongated units in the fibrous bands. The lining cells were disposed in two layers, were slightly hypertrophic and showed a tendency in some places toward textoblastic proliferation, although not nearly so marked as that noted in Case 1.

The left breast weighed 2250 grams and was identical in structure with the right.

A pathological diagnosis was made of bilateral massive hypertrophy of the breast of the adipose type (Figs. 9 to 11).

Case 3. (A276920.) Mrs. R. C., aged 36, was admitted to the Clinic June 30, 1919, complaining of enlarged breasts. She had been married 10 years and had one child nearly 5 years of age. With the exception of an appendectomy performed 6 years before, her past history was negative. Her menses had always been regular in time, amount, and duration, and without pain. The onset of her present condition was associated with her only pregnancy 5 years before when she noticed that both breasts were beginning to enlarge. She was delivered at term of a normal child which she nursed without difficulty. However, her breasts continued to increase in size, and although they did not cause pain she wished to be relieved of their troublesome weight as well as of the impediment which they placed on her normal everyday movements.

The examination revealed nothing important aside from the mammary glands, both of which were enormously hypertrophied, hanging almost to the pubes. On palpation areas of thickening were felt in different portions.

A simple amputation of both breasts was performed July 17, 1919 (Judd). The postoperative course was uneventful and the patient was discharged July 25, 1919, with wounds healed and in excellent general condition.

Pathologist's report. The left breast weighed 2530 grams. The skin was thickened and the nipple flattened. There was no sign of dermatitis or superficial discoloration. On cross section the specimen was found to consist almost entirely of fibrous tissue studded with punctate translucent areas of parenchyma. There were a number of circumscribed encapsulated fibro-adenomata, the largest being 15 centimeters and the smallest 7 centimeters in diameter. There was little or no fat. Sections from the adenomata revealed a stroma composed of differentiating and differentiated fibrous tissue, and of acini presenting the hypertrophy and exaggerated primary cytoplasia or cellular regenerative changes which were described in Case 1. The interadenomatous areas consisted of well differentiated fibrous tissue with areas of

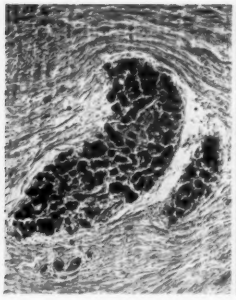

Fig. 13.

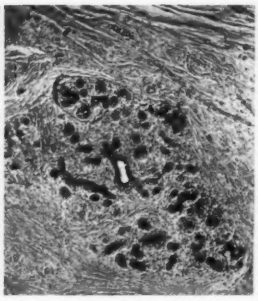

Fig. 14.

Fig. 13. Case 3. Typical lobular grouping of acini.
Fig. 14. Case 3. Intermediate stage of destruction of lobule by invasion of fibrous tissue.

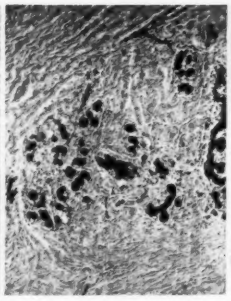

Fig. 15.

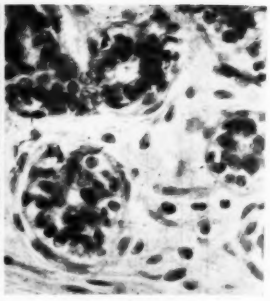

Fig. 16.

Fig. 15. Case 3. Late stage in destruction of lobule by ingrowth of fibrous tissue.
Fig. 16. Case 3. Acini showing exaggerated primary cytoplasia. (×500.)

parenchyma whose acinous units tended to be grouped together after the manner of the parenchyma in the breasts of parous women. However, there was a further interesting feature in this case. The acinar groups in certain fields were circumscribed and while there was no definite capsule, the surrounding fibrous tissue was arranged in a concentric manner. In other areas this arrangement was disturbed by a peri-acinar development of fibrous tissue. In the earliest stages of this process proliferating and differentiating fibroblasts may be seen between the acini. In other areas a further stage was found. The fibrous tissue had developed in the acinous area to such an extent as to compress the parenchyma and cause at first the isolation, later the atrophy, and finally the obliteration of individual mammary alveoli. That the epithelial cells were not without resistance was shown by the fact that in many areas, in the layer of tissue reserve cells (textoblasts), the cells were enlarged and showed morphological signs of reproductive activity.

Fig. 12. Case 3. Fibro-epithelial type of massive hypertrophy which began with pregnancy.

The right breast weighed 2500 grams. The gross and microscopic pictures were essentially identical with those of the left breast. The largest fibro-adenoma measured 3 centimeters and the smallest 1 centimeter in diameter.

A pathological diagnosis was made of bilateral massive hypertrophy of the breast occurring in association with pregnancy; the fibro-epithelial type with multiple fibro-adenomata (Figs. 12 to 16).

Case 4. (A343701.) Mrs. N. F., aged 41, was admitted to the Clinic December 13, 1920, complaining of large, painful breasts. She had been married 21 years and had had three children. Her youngest child was 13. She had not had further pregnancies. Her menstrual history was normal in time of onset, regularity, and flow. She had had an abdominal operation 10 years before of which she did not know details. The onset of her condition had begun 1 year before and 12 years subsequent to her last pregnancy. About this time she also began to suffer from frequent severe headaches and observed swelling of wrists and ankles. Her breasts grew progressively larger until at the time of examination their weight, and the pain, had become a burden.

On examination the patient weighed 166 pounds; her blood pressure was systolic 120, and diastolic 80. There was a slight œdema of the legs and a trace of albumin in the urine. Both breasts were greatly enlarged. The right breast about 10 times normal size, was at least one and one-third times

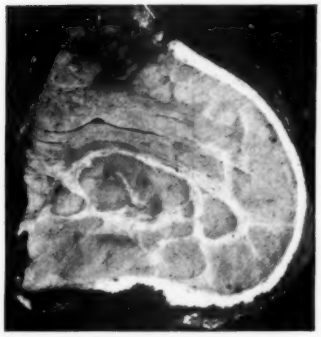

Fig. 17.

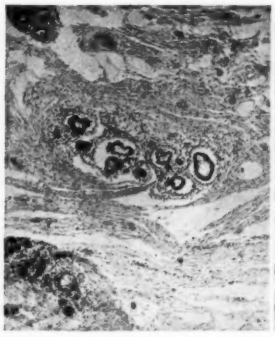

Fig. 18.

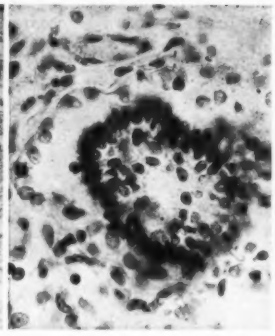

Fig. 19.

Fig. 17. Case 4. Cross section of breast showing distribution of fatty tissue and fibro-epithelial bands which divide the fat into lobes. The histological structure is similar to that in Figure 11, Case 2.

Fig. 18. Case 4. Fibro-epithelial band traversing fatty tissue. The acini show marked primary cytoplasia. (×50.)

Fig. 19. Case 4. Acinus from field in Figure 18, showing primary cytoplasia.) (×500.)

as large as the left. Over both glands the superficial veins stood out prominently. On palpation no lumps or nodules could be detected.

December 15, 1920, a simple amputation of both breasts was performed (Harrington). The postoperative course was uneventful. The patient was discharged from the hospital December 31, 1920, with wounds healed and with general condition excellent.

Pathologist's report. The right breast weighed 2285 grams. The skin was tense, slightly thickened, and the nipple flattened. On section the mass of the breast was found to be made up of pale lemon-colored fat, traversed by a number of connective-tissue bands which divided it into a number of lobular portions. No parenchyma was seen in the fat and the normal anatomy of the nipple zone was obliterated by the adipose overgrowth. Microscopic sections showed the fibrous tissue, as in Case 2, to be highly differentiated and markedly eosinophilic. It contained relatively few acini, those present being lined by a double layer of greatly hypertrophied cells. The cells of the outer layer (textoblasts) were in the process of differentiation and showed the signs of reproductive activity described in the other cases. The acini themselves were small and compressed by the surrounding fibrous tissue. The reproductive activity (primary cytoplasia) of these cells could well be interpreted as a species of biological resistance to their obliteration by the compression brought about by the overgrowth of fatty tissue.

The left breast weighed 1850 grams. The structure was identical with that of the right and needs no separate description.

A pathological diagnosis was made of bilateral massive hypertrophy of the breast, the adipose type, occurring in a parous patient unassociated with pregnancy (Figs. 17–19).

SUMMARY

1. Massive hypertrophy of the breast is of two types: (a) fibro-epithelial and (b) adipose.

2. It may occur between the ages of 12 and 48 but is most frequently associated with puberty or pregnancy.

3. The normal development of the breast seems to depend on the ovary, and there is evidence which strongly suggests that the massive hypertrophy may be etiologically related to an ovarian malfunction.

4. If spontaneous regression of the process fails to occur, surgical amputation is, at present, the preferred treatment.

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BACTERIOLOGY AND PATHOLOGY OF FALLOPIAN TUBES REMOVED AT OPERATION [1]

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THE present report covers an investigation of fallopian tubes from nearly three hundred patients. One hundred and ninety-two of these have been subjected to most painstaking bacteriological and histological study.

Before considering diseased tubes, I wish to make a brief survey of associated previous studies which concerned infections of the external genitalia, the cervix, and the body of the uterus. Investigation of the endometrium of 118 uteri, removed to remedy various pathological conditions,[2] showed that chronic endometritis, as a clinical entity, is very uncommon; persistent infection of the endometrium almost never exists unless maintained by other lesions, such as cervicitis or cellulitis. During the same study of the endometrium, in certain cases normal scrapings were obtained from the uterus; then, several days thereafter, in the endometrium secured by hysterectomy, many bacteria and histological evidence of acute endometritis were found. It would appear, therefore, that curettage is not to be regarded as a perfectly harmless procedure. In the work on tubal infections which is herewith reported, evidence has been obtained which serves to emphasize particularly the dangers of curettage or other uterine instrumentation in patients whose pelvic organs already harbor living bacteria.

Although the corporeal endometrium tends to remain free from chronic infection, histological examinations and cultures from cervices obtained at operation have revealed that bacteria frequently lodge in these tissues, notably in the vicinity of the actively-secreting glands of the mucosa. It has been found, also, that granulations and strictures are often present in the canal of the cervix; the frequency and importance of these granulations and strictures seems not to have been sufficiently recognized.

It should be noted, also, that infection is often present in the upper cervix as high as the level of the internal os. This fact demands special emphasis for several reasons: first, the channel is more constricted near the internal os and infectious processes are particularly stubborn here because free drainage is easily interfered with; second, upper cervix discharges persistently bathe the lower cervix with infectious material and prevent recovery of the latter; again, surgical removal is exceedingly difficult, and even the ingenious operation of Sturmdorf is not sufficiently extensive to yield consistently good results in this type of case.

That special importance attaches to infections of the cervix is evident not only from the disappearance of discharge, but also from notable improvement in general health which follows complete removal of the endocervix or dilatation and radium destruction of the hypertrophic cervical glands.

One other source of chronic leucorrhœa, although less important than disease of the cervix, must be emphasized. This is infection of Skene's ducts. Destruction of these ducts very frequently results in cessation of persistent vulvovaginitis.

Bacteriological Study
(See Table)

The diseased tissues from the 192 cases submitted to bacteriological study have been placed in sterile towels immediately upon removal from the abdomen. Smears have been made and all except portions saved for histological examination have been thoroughly ground and the entire material inoculated into culture media. A considerable variety of media has been used. Meat-infusion-ascites-blood-agar, under partial oxygen tension, had yielded most uniform success in cultivation of the gonococcus.

For convenience in study, these patients have been arranged in three groups: those

[2] A combined bacteriological and histological study of the endometrium in health and in disease. Surg., Gynec. & Obst., 1918, xxvi, 178.

[1] Read before the American Gynecological Society, Boston, June, 1921.

TABLE SHOWING INCIDENCE OF BACTERIA IN PATHOLOGICALLY ALTERED FALLOPIAN TUBES FROM 192 PATIENTS

Type of Cases	Number of cases	No growth	Growth								
			Total number	Gonococcus	Non-hæmolytic streptococcus	Hæmolytic streptococcus	Anaerobic streptococcus	Bacillus coli	Mixed growth	Bacillus proteus	Tuberculosis
Gross evidence of active inflammation	64	29	33	10*	2*	2	5*	3	3*	1	3*
Histological (grossly negative) evidence of active inflammation	38	27	5		4	1					6
No evidence of active inflammation	90	90	0								
Total	192	146	38	19	5	4	5	3	3	1	9

*Both gonoccoci and non-hæmolytic streptococci, 1 patient; anaerobic streptococci with other growth, 1 patient; tuberculosis with anaerobic streptococcus infection, 1 patient.

with grossly active inflammation, those with inflammation demonstrable only upon microscopic examination, and those without definite evidence of an active process.

Cultures were positive in 38 cases, as follows: gonococcus, 19; non-hæmolytic streptococcus, 6; hæmolytic streptococcus, 3; anaerobic streptococcus, 5; bacillus coli, 3; mixed infection, 3; bacillus proteus, 1. Nine revealed tuberculosis.

Gonococcus, 19. It should be emphasized that the cultures have been made from the entire thoroughly ground fallopian tube, with the exception of certain portions reserved for histological examination. In material so studied it has never been possible to obtain gonococci from patients who failed to reveal gross evidence of active inflammation at the time of operation (Table).

It has heretofore been impossible to form a definite clinical estimate of the length of time which the gonococcus remains viable in the fallopian tubes; this is particularly true of those cases in which patients give evidence of recurrently active or persistent tubal disease. It has long been known that gonococci soon disappear from the tubal mucosa, but proof that infection does not persist in the deeper tubal structures has been wanting. Whether the gonococcus produces a chronic salpingitis or these patients suffer from repeated gonorrhœa of the tubes seems to me an important issue. It is, therefore, of interest to note that in this work, in all of which cases the fallopian tubes were ground and promptly cultured according to approved modern methods, it has rarely been possible to obtain viable gonococci from patients who have been free from fever and leucocytosis for a period of more than 10 days or 2 weeks. The fact that good growth was obtained in more recent tubal infections is evidence of satisfactory cultural methods. In view of the many cases studied in this way I feel warranted in the deduction that the gonococcus lives but a short time in the tube; in other words, it seems that the fallopian tube is not to be regarded as a focus of chronic gonorrhœal infection. Persistently active gonorrhœa of the tubes is evidently ascribable either to recurrence of infection from without or repeated invasion of bacteria from the chronically infected lower genital tract.

Detailed description of these 19 cases which yielded gonococci in cultures would not be of material interest. It will perhaps be a surprise to many clinicians that secondary mixed infection has not often been encountered. Only one patient, with exceptional persistence of the gonococcus, merits special attention. This patient, free from symptoms of an acute nature, had been curetted for relief of leucorrhœa and one tube had been removed 6 months before admission

to our service. We found an abdominal fistula communicating with the tube which remained. Upon removal, this tube yielded the gonococcus in pure culture. In so far as could be ascertained, there had been no recent exposure to fresh infection and no instrumentation of the cervix.

The relation of instrumentation to gonococcal disease of the tubes may be illustrated by mention of 5 other patients; 3 of these, previously subject to slight pelvic discomfort, had elsewhere been curetted for relief of leucorrhœa, and thereafter suffered from constant tubal distress; at operation all revealed salpingitis with adhesions. Two others (these treated throughout by me) acquired subacute mild tubal infection following intracervical silver nitrate treatments for relief of leucorrhœa. It seems that there is distinct danger of low-grade salpingitis from repeated instrumentation of the infected cervix.

Non-hæmolytic streptococcus, 6. Not only in the non-hæmolytic group, but also in infections with other types of streptococci, pathological evidence of an active inflammatory process was sometimes encountered long subsequent to the introduction of infection; furthermore, bacteria were more persistent than the pathological evidence would indicate. Streptococci were occasionally isolated in pure culture many months, or even years, after the acute process had subsided.

Non-hæmolytic streptococci were isolated from the tubes of 2 patients with grossly active inflammation and from 4 in whom the microscope was required to reveal that an active process still persisted (Table).

From a patient with history of 2 years' illness, in whom there was a right pyosalpinx and left hydrosalpinx with cystic ovary, both streptococci and gonococci were found in cultures.

Another patient gave history of instrumental termination of a 6 weeks' pregnancy in 1918. Two months later, fearing another pregnancy, she inserted a catheter and also received intra-uterine instrumentation by a physician. Offensive leucorrhœa and pelvic discomfort, increasing in severity, persisted until 1920, when the patient came under the care of Dr. Watkins. Cervical treatments were tried for 1 month. Operation at the end of that time revealed enlarged tubes which were convoluted, but not nodular. The fimbriæ were swollen, slightly adherent, not occluded. Firm adhesions completely covered the retroverted uterus and tubes. Bacteriological study revealed streptococci.

One patient with typical non-hæmolytic streptococcus infection was 48 years of age, with four healthy children. She gave history of two spontaneous miscarriages. Manual removal of the placenta after the first miscarriage, 23 years ago, had been followed by infection with recurrence every few months from that time, the last attack 7 months prior to operation. The abdomen, when opened, revealed monster hydrosalpinx, one ovary of double size, and a large uterus. Numerous colonies of non-hæmolytic lancet-shaped, short-chained streptococci, nonvirulent for rabbits, were present in cultures.

The other 3 patients whose tubes yielded non-hæmolytic streptococci all gave history of prolonged illness subsequent to abortion with infection.

Hæmolytic streptococcus, 3. A patient who had long suffered from moderate pelvic pain had elsewhere been dilated by means of a laminaria tent and then curetted. She entered our service acutely ill. A mass, apparently in the right tube, extended into the cul-de-sac and yielded foul pus on vaginal puncture. Cultures showed great numbers of hæmolytic streptococci.

Another patient, with history of gonorrhœal infection, had a fist-sized tubo-ovarian inflammatory mass; the other tube showed typical gonorrhœal changes upon both gross and microscopic examination. Smears and cultures contained many long-chained hæmolytic streptococci, but no gonococci. It appears probable that there had been a primary gonorrhœal salpingitis with implantation of subsequent streptococcus infection.

Hæmolytic streptococci were obtained from one patient, 34 years old, with history of abortion from an unknown cause at the age of 29. She suffered from severe persistent pelvic pain. Drainage, performed 2 months before operation, yielded an abundant tenacious fluid containing gram-positive diplo-

cocci. Upon abdominal section both tubes and ovaries were found buried in old inflammatory exudate and adhesions, and were difficult to identify. Histological examination of the tubes revealed thickening, large areas of lymphocytic infiltration in the deep wall of the tube, and an intact endosalpinx with much cellular exudate, including a moderate percentage of plasma cells. Cultures yielded enormous numbers of hæmolytic streptococci. Rabbits injected intravenously with these bacteria developed purulent arthritis and acute nephritis.

Anaerobic streptococcus, 5 (see "mixed growth"). A large patient, with postabortive pelvic infection of 2 years' duration, failed to improve after many months of palliative treatment. At operation there was ruptured a thin-walled cystic mass deeply buried in the left pelvis. The contents were serous but foul-smelling. The tube and ovary on that side were adjacent to the mass, much enlarged and firmly adherent. The resistance of adhesions was particularly noted. Cultures contained numerous colonies of anaerobic streptococci.

A patient with one son wished to avoid further child-bearing. She had been repeatedly aborted without serious trouble until, finally, two successive attempts to rid the uterus of another pregnancy were followed by severe infection. Upon subsidence of acute symptoms she remained incapacitated because of persistent distress in the right lower quadrant, and continued to suffer greatly at the time of my first examination, 6 months after the onset of infection. A cyst-like inflammatory mass was palpable in the right pelvis. There was no fever, no leucocytosis. At operation was found a foul-smelling right ovarian abscess the size of a grape-fruit, the right tube firmly adherent and semi-necrotic, the fimbriæ free. The other tube was also adherent to the abscess and œdematous, but was free at the fimbriated extremity. Smears of the pus revealed numerous gram-positive diplococci and a smaller number of small gram-negative bacilli. In cultures, the gram-negative bacilli failed to develop, but anaerobic streptococci were present in rich pure growth. These streptococci were not virulent for experimental animals.

A woman of 43, married 6 years, had never been pregnant. The history and physical examination indicated a persistently recurrent gonorrhœal infection of the fallopian tubes. Upon removal, the tubes were found to be considerably enlarged, with greatly thickened walls and closed fimbriated ends, the lumen filled with green-yellow pus. A rich growth of long-chained anaerobic streptococci was recovered in pure cultures. There were no gonococci.

A patient who had been operated upon 3 years before, for chronic disease of the tubes, presented an abdominal sinus. This sinus communicated with an enormous necrotic ovary by means of an almost solid fistulous tract, the size of one's little finger. Smears and cultures from the necrotic material yielded great numbers of anaerobic streptococci. Histological examination showed typical tuberculous changes.

Bacillus coli, 3. A patient married 37 years, never pregnant, with history of chronic vesical distress and chronic pelvic pain, had greatly enlarged tubes closed at the fimbriated ends. One tube contained thick yellow pus; all other evidence indicated chronic salpingitis of gonorrhœal origin. Bacillus coli was recovered in pure culture from the pus as well as from the ground wall of the tube.

A girl with history of gonorrhœal infection for over 1 year was operated upon for relief of a persistent ovarian abscess. This abscess contained nearly a litre of pus and revealed numerous colon bacilli in smears and cultures. There were no gonococci. The chronically diseased tubes presented both gross and microscopic changes typical of gonococcal infection.

A somewhat similar case is that of a young woman with an infected thick-walled cyst of the ovary. Both tubes were enlarged and chronically inflamed, with pathological changes typical of gonorrhœal disease. Cultures revealed pure growth of bacilli of the colon group.

From the tubes of several other patients occasional colonies of colon bacilli were isolated.

Mixed growth, 3. In two patients, whose clinical history and external genital examination pointed toward venereal infection, persistent tubo-ovarian abscesses were encountered. Numerous bacteria, chiefly gram-negative cocci, were obtained. There were no gonococci, but pathological changes were typical of that disease.

In this connection it should be mentioned that colonies of staphylococci and diphtheroid bacilli, notably the former, have been fairly numerous throughout this work. Except when many colonies have been present, the control histological study has permitted the inference that they were incidentally present; more numerous colonies have a few times been suspected to play a more important rôle.

A patient who was free from venereal disease and had been infected as the result of criminal abortion, was thereafter curetted and subsequently underwent vaginal drainage for an accumulation of pus in the pelvis. Symptoms persisted from that date. At operation, 1 year later, we found a greatly enlarged left ovary containing a small amount of foul pus. The tubes were densely adherent, three times normal size and very firm; the fimbriæ were open. Both smears and cultures revealed anaerobic streptococci and fusiform bacilli; also a considerable mixture of other bacteria, notably staphylococci.

Bacillus proteus, 1. A patient without history or external evidence of venereal infection, whose husband upon examination revealed no suggestion of gonorrhœa, was operated upon for relief of pelvic infection. Both tubes were moderately enlarged and one contained mucus and blood. The fimbriated extremities were not occluded. Bacteriological study revealed a rich growth of bacillus proteus in pure culture. Histological examination showed an active inflammation of the endosalpinx. There were numerous polynuclear leucocytes and many round cells, of which a large proportion were plasma cells. The inflammation was restricted to the vicinity of the tube lumen; the deeper mucosa and muscle layer were essentially free from invasion. Integrity of the columnar epithelium and absence of adhesions between the folds of endosalpinx were also noted.

Pathology[1]

A. Gonorrhœal Disease of the Tubes

From the clinical history, examination of the external genitalia, and evidence obtained at operation, together with laboratory study of the tubes in this series of nearly 300 patients, it has been possible to determine that gonococcal infection was responsible for the pathological changes in more than 70 per cent of the cases. Approximately 10 per cent more were thought to have been primarily infected with the gonococcus, but this could not be determined with certainty.

The gross features of recently diseased gonorrhœal tubes require no description. That they become enlarged, particularly at the outer ends, that they fall downward and backward, that the fimbriæ become occluded, and that adhesions are numerous, is common knowledge. It is less well known that after cessation of the active process, those tubes which have undergone only catarrhal changes, without retention of fluid within the tube, rarely show much enlargement; often they are atrophic. There is a tendency to remain indurated and somewhat nodular, and, whenever other lesions persist, it is usual to find occlusion of the fimbriæ.

Several tubes, with only slight changes, have served to verify the mechanism of tubal occlusion described by Ries.[2] It appears that inflammation of the serosa is followed by scar formation which, upon contraction, makes a more or less complete purse-string closure, with inversion of the fimbriæ.

More frequently, perhaps, and notably in the presence of ovarian infection or other extensive inflammation, the tube occludes by plastering itself upon the ovary, uterus, or broad ligament.

It has been particularly noted that a single attack of salpingitis seldom results in marked permanent increase in thickness of the tube wall. Greatly thickened tubes are most often

[1] For literature concerned with the pathology of salpingitis of acute infectious origin, the reader is referred particularly to the following: Schridde, Deutsch. med. Wchnschr., 1909; also Verhandl. d. Gesellsch. deutsch. Naturf. u. Aerzte, Leipzig, 1908, lxxx, 2 Th., 2 H., 47; Amersbach, Monatschr. f. Geburtsh. u. Gynaek., 1910, xxxii, H. 4, 444; Heynemann, Ztschr. f. Geburtsh. u. Gynaek., 1912, lxx, 870; Ploeger, Arch. f. Gynaek., 1911, xcv, 634.

[2] Ries, E. The mechanism of occlusion of the tube. Am. J. Obst., 1909, lx, No. 2.

associated with repeated exposures. If the patient can be early isolated from the source of her infection there is reason to expect moderate tubal changes. Only occasionally are gonococci sufficiently virulent to make an exception to this general rule.

Persistent pyosalpinx exemplifies gonorrhœal infection in severe form; it is particularly characterized by hyperplasia and induration of the tube wall. In a lesser measure the same holds true for the tubal changes of hydrosalpinx. The belief that hydrosalpinx and pyosalpinx are fundamentally different lesions has not been borne out by this study. A comparison of histological material reveals innumerable gradations from one to the other.

In greatly thickened old tubes, blood vessels are very numerous. Aside from recognized tubal pregnancy, none of which cases is wittingly included, there have been studied more than half a dozen such tubes with rich blood supply in which there was extensive hæmorrhage within the tube lumen. By means of serial sections it was possible to demonstrate the site of blood vessel rupture in one case. The question arises whether we have not placed too much reliance upon hæmatosalpinx as a dependable evidence of tubal gestation. Possibility of this error is increased by the fact that microscopic examination of these blood-filled, greatly thickened tubes reveals an overgrowth of distorted villi which might easily be mistaken for the chorionic villi of pregnancy.

So-called "salpingitis nodosa" has been the subject of much discussion. There has been a tendency to ascribe all of these tubal nodulations to gonorrhœal infection. Some few authors have adhered to the belief that they are due to congenital anomalies. All are agreed that the majority of such tubes reveal, histologically, nests of gland-like columnar epithelium buried beneath the mucosa. My experience agrees with that of Ries,[1] who asserts that nodules of the tube are due to many causes, inflammatory and non-inflammatory; the microscope best explains the etiology of any doubtful case. It would appear that the vast majority are inflammatory in origin, notably the result of gonorrhœal infection; less often tuberculosis is responsible. That gland-like nests of cells need not necessarily be present is evident from study of a tube which revealed, grossly, a typical picture of salpingitis nodosa, and microscopically presents an interstitial gonorrhœal abscess (Fig. 1). A grossly identical nodule, incidentally discovered at the time of appendectomy, was removed from a patient with many children and without history or evidence of infection; this proved to be an adenomyoma of the tube (Fig. 2).

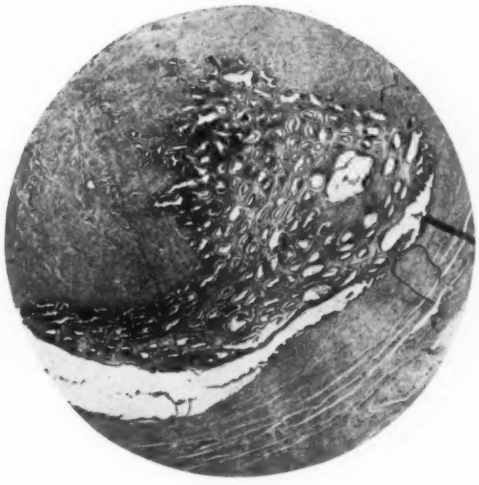
The adhesions encountered in gonorrhœal cases possess a distinctive clinical characteristic; they can be separated by manipulation or blunt dissection, without cutting. When the tubes and ovaries could not be freed in this manner, irrespective of the severity or duration of the salpingitis, there was evidence of infection with other bacteria. There was a single notable exception; a young married woman had been assaulted when a girl and at that time suffered from symptoms typical of gonorrhœal disease. External examination revealed evidence of healed infection which substantiated the history. At operation there was found a matting together of the pelvic viscera, such as has been encountered after extensive radium treatment of cancer cases. Although I was tempted to ascribe the pathological changes to an associated infection with other bacteria, neither history nor laboratory evidence justified that assumption. Upon two other occasions when very dense inseparable adhesions were encountered, there was no pre-operative history of disease other than gonorrhœal infection; it was subsequently learned, however, that both patients had previously undergone instrumental abortion with severe infection.

Histology. In the early stages there is swelling of the endosalpinx with more or less destruction of the columnar epithelium. Fusion of adjacent folds of villi is frequent; this is a characteristic feature. Later, the mucosa often becomes much crippled and distorted. Gland-like nests of columnar epithelium are sometimes found deeply buried in the wall of the tube and inflammatory diverticula extend far beneath the mucosa

[1] Ries, E. Nodular forms of tubal disease. J. Exper. Med., 1897, ii, 347.

Fig. 1.

Fig. 2.



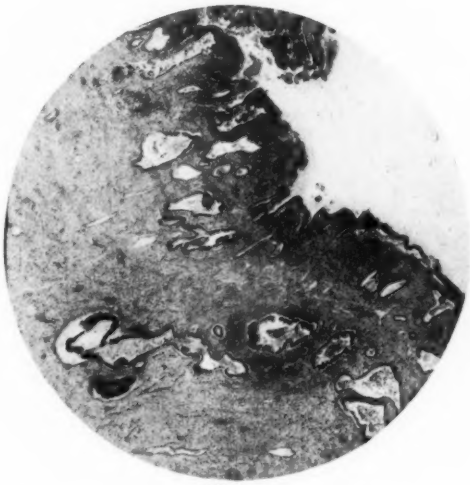


Fig. 3.

Fig. 4.

Fig. 1. Salpingitis nodosa. Microscopically, a gonorrhœal abscess in the tube wall.

Fig. 2. Salpingitis nodosa. Grossly identical with the nodule seen in Figure 1. Serial sections reveal an adenomyoma of the tube. Removed from a patient with many children and without history or evidence of pelvic infection.

Fig. 3. Gland-like nests of columnar cells buried in wall of tube. Gonorrhœal infection. Longitudinal and serial sections reveal that these nests communicate with the tube lumen.

Fig. 4. Mucosa of healed gonorrhœal tube; typical adhesions between villi.

(Fig. 3); this is particularly true of tubes with pyosalpinx or hydrosalpinx.

The cellular exudate of gonorrhœal salpingitis is not confined to the mucosa but penetrates all layers of the tube wall. The most intense inflammatory reaction, however, is in the mucosa, and here it persists until healing is complete.

Aside from polynuclear leucocytes, whose numbers vary in proportion to the activity of the process, lymphocytes and plasma cells predominate. The exact diagnostic significance of plasma cells as evidence of gonorrhœal infection requires mention. Plasma cells are characteristic of gonorrhœal salpingitis and most strongly suggest this disease. But it may be positively stated that they are not to be depended upon as pathognomonic; they are often present and are sometimes numerous after non-gonorrhœal postabortive infection.

In the course of time, if there has been only a catarrhal salpingitis, there may remain very little change in the tube. All cellular exudates may eventually disappear, but, even with excellent recovery, the microscope reveals adhesions between villi (Fig. 4) and an unusually abundant blood supply.

After pyosalpinx, and to a lesser degree after hydrosalpinx, all histological lesions in the healed tube are more extreme than those which follow simple catarrh of the tube. In that portion not thinned out by fluid pressure there is hyperplasia of the wall and a varying amount of distortion of the muscle layers. The previously mentioned nests of columnar epithelium are particularly worthy of mention. Longitudinal or serial sections of the tube reveal that most of these deeply buried gland-like nests of columnar cells are really connected with the mucous lining of the tube.

B. TUBAL DISEASE OF OTHER ACUTE INFECTIOUS ETIOLOGY [1]

In somewhat more than 15 per cent of these patients the tubal pathology is believed to have been entirely due to other pus-producing bacteria, notably streptococci.

Tabulation of the gross changes encountered in these non-venereal infections reveals that, when salpingitis occurred, it was most often but a part of the pathological picture rather than the chief lesion. Cases in which the tubes present the essential pathology seem not usual in such infections. The most notable exception to this is the fairly frequent occurrence of non-gonorrhœal hydrosalpinx. Occasionally pyosalpinx complicates a puerperal abscess of the ovary.

The diagnosis of salpingitis of a non-gonorrhœal nature is usually possible even in the absence of growth in cultures. As just mentioned, the tubal changes may present but a minor part of the picture. The typical lesion consists in perisalpingitis with adhesions which vary in number and density (Fig. 5). The adhesions are often delicate and few; this seems particularly to characterize mild colon bacillus infections. On the other hand, virulent streptococci leave most dense adhesions without available lines of cleavage. Firmly bound, matted tissues, which resist all attempts at blunt dissection speak strongly for streptococcus or tubercu lous infection. Even though there has been a primary gonorrhœal salpingitis, adhesions which necessitate extensive cutting suggest that other infection has also been present.

The tube walls may reveal little change. Palpable induration is often wanting. The fimbriated ends tend to remain patulous. The microscope most often fails to show extensive changes of the endosalpinx.

Even if there be extensive inflammation of the endosalpinx, few adhesions form between the folds of the mucous membrane provided the fimbriated ends of the tubes remain open (Fig. 6).

There is much less desquamation of the epithelium, and plasma cells are less common than in gonorrhœal infection. The assertion that the villi are never so filled with cellular exudate and are never so "fat" as in gonorrhœal disease, is contrary to my experience.

In those much less common cases which present occluded fimbriæ and accumulated fluid within the tube, attempts to differen-

[1] The conclusion that gonococci had not been present is based upon negative evidence as well as upon examination of the diseased pelvic organs. When possible, an examination of the husband, including a search of the urine for residual evidence of old infection, has been made. Uncertain cases, those patients with thickened Skene's ducts, urethral granulations, Bartholin duct involvement, or with history of notable urinary disturbance, are excluded from the non-gonorrhœal group.

Fig. 5.

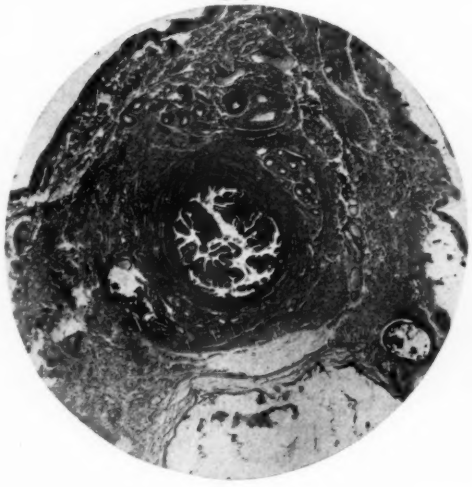
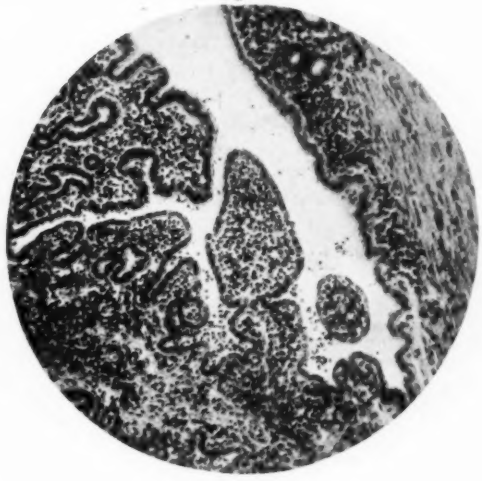


Fig. 6.



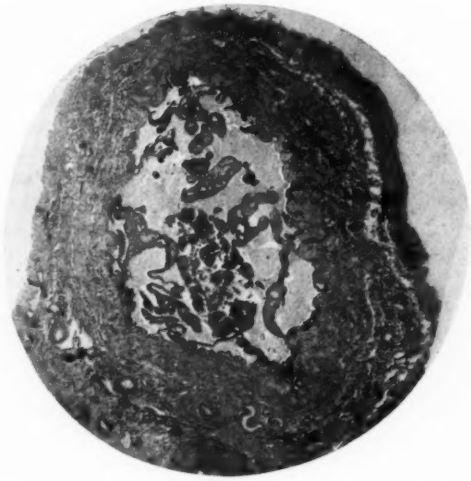


Fig. 7.

Fig. 8.

Fig. 5. Typical non-gonorrhœal tubal lesion. Marked perisalpingitis with adhesions. The fimbriæ are usually free, the mucosa little affected.

Fig. 6. Non-gonorrhœal tubal disease, which is less common than that which is shown in Figure 5. Even with extensive inflammation of the endosalpinx, as here shown, few adhesions form between the villi provided the tubes remain patent. This patient had persistent tubo-ovarian streptococcus infection; operation 1 year subsequent to pelvic drainage of puerperal abscess.

Fig. 7. Streptococcus hydrosalpinx; a less common type of non-gonorrhœal tubal lesion. Such tubes reveal adhesions between villi, buried nests of columnar cells, and other features supposed to characterize gonococcus infection; histological evidence alone is inadequate for positive differential diagnosis.

Fig. 8. Tuberculous salpingitis. The mucosa is the chief seat of infection. Hyperplasia of the mucosa, dense adhesions between villi, great numbers of giant cells, and extensive tubercle formation are usual microscopic features.

tiate from the corresponding tubes of gonorrhœal disease have been unsatisfactory. My experience indicates that the villi frequently adhere; buried nests of columnar cells are found, just as in gonorrhœal infection. There is perhaps a tendency to less cellular infiltration. Plasma cells are not so evident. If we may judge from the present study, however, it is extremely difficult to make a certain diagnosis of streptococcic hydrosalpinx or pyosalpinx from the histological evidence alone.

C. TUBERCULOUS SALPINGITIS (EXCLUSIVE OF GENERALIZED TUBERCULOUS PERITONITIS)

Tuberculous tubes, in the absence of generalized tuberculous peritonitis, were encountered in 5 per cent of these patients.

Not once was tuberculosis diagnosed in the operating room, although several times suspected and looked for. Careful postoperative scrutiny in the laboratory revealed gross tuberculosis in less than one-half of these patients; in 3 an appearance suggestive of tuberculosis was confirmed by the microscope.

Nearly all of these tubes were held by dense adhesions; in only a few cases were they comparatively free. Many of the adhesions could not be separated by blunt dissection and were firmly resistant even on cutting.

In general the gross pathology was similar to severe recurrent gonorrhœal salpingitis. Pallor was sometimes a distinctive feature. The tubes were all considerably enlarged and usually much indurated. Pus tubes of enormous size and tubes with extensive calcification, as described by Williams[1] and others, were not encountered.

The fimbriated extremities of the tubes were adherent or occluded in two-thirds of the cases; caseous material could be expressed from some of the tubes which remained open. Experience with this small group of patients indicates that occlusion of the fimbriæ is frequent, but distinctly less usual than in gonococcus infections of corresponding severity.

The opened tubes revealed that thickening was chiefly due to hyperplasia of the mucosa. The tube lumen was often tortuous, partly obstructed or obliterated. Gross tubercles and ulcerations, although present, were not observed in this series so numerously as in Williams' cases.

The chief histological features were adhesions between the hyperplastic folds of mucosa, great numbers of giant cells, and numerous tubercles. The muscle layers and serosa were seldom involved.

[1] Williams, J. Whitridge. Tuberculosis of the female generative organs. Johns Hopkins Hosp. Reports, 1893, iii, 85.

CONCLUSIONS

1. From the clinical history, examination of the external genitalia, and evidence obtained at operation, together with laboratory study of the tubes in this series of nearly 300 patients, it has been possible to determine that gonococcal infection was responsible for the pathological changes in over 70 per cent of the cases. Approximately 10 per cent more were thought to have been primarily infected with the gonococcus, but this could not be determined with certainty.

2. In somewhat more than 15 per cent of these patients the tubal pathology appears to have been entirely due to other pus-producing bacteria, notably various types of streptococci.

3. Tuberculous tubes, in the absence of generalized tuberculous peritonitis, were encountered in 5 per cent of the cases.

4. Bacillus coli is particularly frequent in tubo-ovarian abscesses of large size. As a primary cause of salpingitis neither the colon bacillus nor the staphylococcus appears to be of notable importance.

5. It has almost never been possible to obtain gonococci in cultures from thoroughly ground fallopian tubes removed from patients who have been free from fever and leucocytosis for a period of more than 10 days or 2 weeks. The fallopian tube appears, therefore, not to be a focus for chronic gonorrhœal infection. Persistently active gonorrhœa of the tubes is evidently ascribable either to recurrence of infection from without or repeated invasion of bacteria from the chronically infected lower genital tract.

6. Tubal infections with various types of streptococci yielded pathological evidence of an active inflammatory process long subsequent to the introduction of infection, and streptococci were occasionally isolated many

months, or even years, after the acute process had subsided.

7. Gonorrhœal pelvic infection primarily involves the tubes, with resultant thickening, induration, closure of the fimbriated ends, and pelvic adhesions which are amenable to separation by blunt dissection. Microscopically, the folds of the mucosa are found adherent, pockets of gland-like columnar epithelium extend deeply into the wall of the tube, blood vessels are numerous, and plasma cells are characteristic.

8. If the patient can be early isolated from the source of her infection, a single attack of gonorrhœal salpingitis is usually borne without protracted clinical symptoms or severe pathological results. Greatly thickened tubes are most often associated with repeated exposures.

9. Implicit reliance should not be placed upon hæmatosalpinx as dependable evidence of tubal gestation. Hæmorrhage may occur in greatly thickened gonorrhœal tubes.

10. Salpingitis nodosa, although most frequently of gonorrhœal origin, may be due to one of many causes, either inflammatory or non-inflammatory; the microscope best explains the etiology of any doubtful case.

11. In streptococcus infection tubal involvement is usually but a part of the picture. Perisalpingitis is the most frequent type of tubal lesion. Even though there be an extensive salpingitis, the fimbriated extremities will very likely remain open; the mucous membrane folds, or "villi," of such tubes show few adhesions. On the other hand, with the less common occurrence of occluded fimbriæ and accumulated fluid within the tube, adhesions are present between the villi and there are nests of columnar cells in the tube wall; differentiation from the gonorrhœal tube is then difficult.

12. Tuberculosis is very likely to be overlooked if routine histological preparations are not made. When limited to the pelvic organs it is difficult to establish a diagnosis from the gross appearance alone. Unusually resistant adhesions suggest tuberculous or streptococcus infection.

13. Somewhat similar operative measures appear indicated in streptococcus and in tuberculous salpingitis. In both diseases infection is not usually confined to the tubes; in both, viable bacteria are often still present in the tissues at the time of operation and there is danger of chronic-postoperative infection of the ovaries. Particularly in regard to extirpation of the ovaries, more radical surgery appears indicated than in gonorrhœal infections of corresponding severity.

14. The results of this work again direct attention to the dangers of uterine instrumentation. Nearly all streptococcus infections in this series were traceable to instrumental abortion or subsequent intra-uterine manipulation; some tubal infections recurred after curettage; tent dilatation was followed by streptococcic pelvic abscess. It would appear that the normal uterus and fallopian tubes are comparable with an unopened tube of culture media; passage of instruments through the bacterial barrier of the internal os is analogous to removal of the cotton plug, and nature is not always able successfully to combat infection before serious lesions have resulted. This is particularly true if infection which has been previously introduced is stirred up through subsequent instrumentation.

THE TREATMENT OF PYELITIS[1]

By HERMAN L. KRETSCHMER, M.D., F.A.C.S., Chicago

THIS paper is based upon a study of 200 cases of renal infection. Lesions of the kidney and lower urinary tract of a definite surgical nature, such as renal tumor, stone and tuberculosis, stricture and stone of the ureter, infections of the kidney secondary to hypertrophy and carcinoma of the prostate, carcinoma and calculi of the bladder, and strictures of the urethra are not included. The series, therefore, includes cases that are usually designated as pyelitis or pyelonephritis.

CLASSIFICATION

The 200 cases may be divided into the following clinical groups: pyelitis of infancy and childhood, pyelitis of pregnancy, pyelitis of matrimony, pyelitis following surgical operations, and cases of simple pyelitis.

Colon pyelitis occuring in newly married women has been termed by Wildbolz (1) "defloration pyelitis." This type of colon infection has also been described by Rosving (2), Sippel (3), and doubtless others. In some of these cases there may or may not be a coexisting involvement of the bladder. It is believed that tears of the hymen serve as atria through which the colon bacilli gain entrance.

In this series there occurred 3 cases that belong to this group or classification.

PREDISPOSING FACTORS

In this group of cases, careful search was made for the presence of lesions of other organs which might in some way have been factors in predisposing to the occurrence of kidney infections or which might perhaps have been instrumental in causing relapses or in some way have contributed to the failure of treatment.

Early in this work I was impressed by the fact that many of the patients had lesions of the gastro-intestinal tract. These were chiefly bowel lesions, and, of these, constipation headed the list. Thirty per cent of the patients gave a history of constipation of varying degree, for which laxatives and purgatives were used, in some instances, almost to abuse. In a small number of instances, the patients suffered from lesions of the rectum such as hæmorrhoids, and from lesions of the anus, such as fissures and fistulæ; these may undoubtedly have been factors in producing colon bacillus infections and must be taken into consideration in each case when the general plan of treatment is outlined.

Lesions of the male genital tract received due consideration. The presence of infection in the prostate and seminal vesicles was established by rectal examination, and by examination of the strippings obtained from the prostate and seminal vesicles for the presence both of pus and of micro-organisms. In several cases in which we were able to clear up the kidney infection, the patients were sent back to the family physician who was instructed to continue treating the prostate and seminal vesicles by the usual methods. In those instances in which this part of the treatment was not carried out, there were recurrences of the kidney infection. On the other hand, when the infections in the prostate and seminal vesicles were finally cleared up, the kidneys remained free of infection; hence it has been routine in treating our cases of pyelitis in the male to direct the treatment not only to the kidney but also to the prostate and seminal vesicles whenever they showed the presence of infection, recent or remote. Of the 78 male patients whom we have had under observation and treatment 31, or 39.7 per cent, had infections of the prostate, the seminal vesicles, or both.

Age. Renal infections may occur at any time of life although the largest number of cases that come under observation are seen in adults. Recent observations show that infants and children often suffer from pyelitis. No doubt many of the cases of cystitis in infants and children are in reality cases of pyelitis, in substantiation of which assertion mention should be made of a recent publication on colon bacillus infection of the urinary tract

[1] Read before the Evanston Branch of the Chicago Medical Society, Evanston, Illinois, February 27, 1921.

in infants and children in which it was shown that all the cases were pyelitis, cystitis pure and simple being strikingly absent. (4)

In the present series there were 24 cases of pyelitis in infants and children between the ages of 7 months and 10½ years. The youngest patient treated was 7 months old and the oldest 75 years old.

TABLE OF AGES

7 months	to 10 years	24
11 years	to 20 years	4
21	to 30 years	42
31	to 40 years	51
41	to 50 years	26
51	to 60 years	24
61	to 70 years	14
71	to 80 years	5
Age not stated		10

From the foregoing table it will be seen that the largest number of cases, 25.5 per cent, occurred between the ages of 31 and 40.

Sex. Formerly it was believed that renal infections were rare in women. The perfection of modern diagnostic instruments and the recent intensive study that has been devoted to this topic have completely disproved this old view. Indeed, if one takes into consideration certain renal infections which occur only in women, such as pyelitis occurring during and after pregnancy, the number of cases of pyelitis in girl babies, the association of renal infections with lesions of the female generative organs, and the onset of renal infections after extensive gynecological operations, one may safely say that renal infections occur more frequently in women than in men. An analysis of the series showed the following: males, 39 per cent; females 61 per cent. Thus it will be seen that this condition occurs much more frequently in women than it does in men. These figures are in accord with the views generally held that pyelitis occurs much more frequently in women than in men.

BACTERIOLOGY

The statement is very often made that colon bacillus infection of the kidney is the infection most frequently seen clinically. This statement is borne out by an analysis of the bacteriology of these 200 cases. Colon bacilli were present in 132 cases; staphylococci in 28 cases; streptococci in 1 case; colon bacilli and staphylococci in 10 cases; streptococci and staphylococci in 2 cases; and in 27 cases the cultures were not stated.

With reference to the relative frequency regarding the location of the infection, it may be stated that in this series 99 cases showed positive cultures from both the right and the left sides; in 32 cases, positive cultures were obtained from the right kidney only; and in 17, from the left kidney only; and in 21 cases the bladder and right and left kidneys showed sterile cultures although pus was demonstrated microscopically in these cases. Therefore, these 21 cases should be added to the 99 bilateral cases previously mentioned, bringing the total number of bilateral cases up to 120. In 6 cases the bacteriology, as previously mentioned, was not stated and in 25 cases cultures of the bladder only were given.

Many of the cases in which the cultures were recorded as sterile were seen in the early part of the work before definite routine procedure was established; therefore it can readily be understood that at present the reports of sterile cultures are decidedly unsatisfactory. When the urine shows the presence of pus and sterile cultures, the urine is centrifuged and stained for organisms. On many occasions the urine has shown the presence of bacteria upon stain while the cultures have remained sterile.

These cases are treated by pelvic lavage until the urine is free of pus, the report of sterile cultures not deterring us in any way from using this method of treatment. Needless to add that in this type of case guinea-pigs are inoculated in order to exclude the possibility of renal tuberculosis.

CYSTOSCOPIC DATA

More or less accurate cystoscopic data were available in 177 of the 200 cases, but in 23 cases the cystoscopic records were incomplete. Of the 177 cases in which the findings were recorded, pathological changes were seen in 128 of the cases. Some of the publications on this subject stated that the bladder was negative in a large number of instances. Thus, Geisinger (5) stated that in 40 per cent of his cases the bladder pictures were absolutely negative. In our series normal bladders were seen in only 49 cases, or about 25 per cent.

These figures agree with those of Thomas (6) who reported normal bladders in 25 per cent of his cases. From these figures it is evident that careful cystoscopic examinations showed changes in the bladder in about 75 per cent of the cases. These changes varied in intensity from a slight amount of hyperæmia around the internal urethral orifice to a severe generalized cystitis. In some cases there were irregularities of the sphincter, œdema or congestion of the trigonum, and flakes of pus adhering to the bladder wall. In one case the bladder itself was normal but the ureters were dilated. In one case a small papilloma of the bladder was found and was considered as an incidental finding, having produced no symptoms and being no larger than a small pea. The general impression has been that in cases of pyelitis the bladder is normal. This has not been my experience. It has generally been supposed that the bladder is resistant to infection. This is supposed to account for the rare presence of cystitis in pyelitis; but, while this may be true, the evidence obtained does not appear to substantiate the belief that cystitis is uncommon in cases of pyelitis.

Pyelography. In a certain number of cases pyelography was carried out, the pyelograms obtained showing the usual picture of infection. Pyelography was not carried out as a routine unless there seemed to be some special indication for so doing. Pyelograms in several instances have helped to differentiate between a simple pyelitis and a surgical condition of the kidney which might have been mistaken for pyelitis and treated as such. In this way I have been spared the embarrassment of lavaging patients whose condition called for surgical treatment.

SYMPTOMS

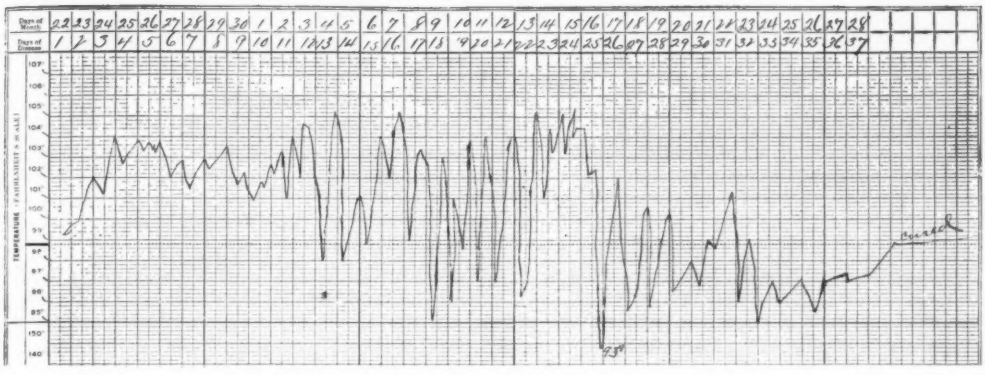
An analysis of the more prominent symptoms showed that bladder distress was the most common complaint; of the bladder symptoms, frequency of urination headed the list. Frequency of urination was present in 66½ per cent of the cases; burning on urination was noted in 37½ per cent; painful urination in 30½ per cent; in 32½ per cent of the cases the patients noted turbidity of the urine; in 24 per cent of the cases, patients complained of blood in the urine which was generally described as not being very severe; urgency was present in 8 per cent of the cases; incontinence in 5 per cent; difficulty of urination in 9½ per cent; nausea and vomiting in 11½ per cent; nausea alone in 2½ per cent; vomiting alone in 2½ per cent; sweats in 9½ per cent; chills in 23 per cent. In 37½ per cent of the cases a definite history of fever was obtained. The amount of fever varied, especially in some of the cases associated with pregnancy in which the fever was unusally high and was associated with a very severe drop in temperature.

The cases of pyelitis of pregnancy appeared to be more severely and more acutely ill than the ordinary cases. Not infrequently the patients had a very severe pallor and there was profound prostration. The greatest excursions in the temperature were likewise seen in the cases of pyelitis of pregnancy (see chart).

DIAGNOSIS

The diagnosis of infection of the renal pelvis is not a very difficult one. The symptoms in the acute cases, as well as in some of the chronic cases, may be confusing and, as is evident from a review of this series of cases, colon pyelitis, acute and chronic, has been mistaken for a variety of diseases. It would appear from a review of these cases that the causes for overlooking renal infection are due to the fact that frequently a symptomatic diagnosis is made without a careful examination of the urine. A provisional diagnosis may be ventured in a large number of cases if pus, bacteria, and occasionally a few red blood cells in the urine are associated with the symptoms. In the group operated upon as cases of acute appendicitis, this error might have been avoided had a catheterized bladder specimen been examined.

The final definite diagnosis of renal infection must, of course, be based upon an examination of the urine obtained by the ureteral catheter, and this means that the patient must be subjected to a cystoscopic examination. The first step, therefore, in the diagnosis is to demonstrate the presence of pus and bacteria in the urine. The second step is to determine the origin of the abnormal elements found, whether renal or vesical.



Illustrating temperature curve in case of pyelitis of pregnancy.

After having determined the source of the pus, whether from the right side, the left side, or from both sides, the next problem is concerned with a differentiation of the various kidney lesions which are associated with the presence of pus and bacteria. This must necessarily exclude lesions of the ureter, such as strictures and stone, stone in the kidney, renal tuberculosis, tumor, and hydronephrosis.

The smallest source of error has been in cases in which the pus has been established as renal in origin, this resulting in the belief that in instances in which patients are subjected to a routine urological examination, the percentage of error in diagnosis is relatively small. The large number of cases in which either the diagnosis was not made or a wrong diagnosis was made, were the cases that were not carefully studied, and it would appear that the largest source of error was due to the fact that careful examinations of the urine had not been made.

With a good roentgen-ray technique, stone in the kidney and ureter can be excluded. With plates of good quality and careful reading, the percentage of stones overlooked is small. However, in a certain number of cases stones have been overlooked for one or several of the above-mentioned reasons.

The presence of renal tuberculosis often may be masked by the presence of colon bacilli and such cases are often treated by pelvic lavage. This, of course, would occur in cases of renal tuberculosis early in their course, that is, at a time before there is involvement of the bladder. In the series presented here, there were several instances in which a provisional diagnosis of colon bacillus infection was made because of the absence of bladder evidence of tuberculosis. Very diligent search for the presence of tubercle bacilli in the direct smear, and when this was negative, repeated guinea-pig inoculations have prevented wrong diagnoses.

Stricture of the ureter, large hydronephroses and renal tumor can be differentiated by the pyelogram.

An incorrect diagnosis is made in a great number of patients suffering from pyelitis as is evidenced by a review of this series of cases. The diagnoses have varied. Many of the patients were diagnosed as surgical cases, having been operated upon for some supposed surgical condition without obtaining relief from these symptoms.

PREVIOUS OPERATIONS

Of more than passing interest was the fact that 89, or 44½ per cent, of the patients gave a history of having had some sort of surgical operation. The patients who gave a history of having been operated upon may be divided into four groups.

Group 1. This group represents the patients who were operated upon on account of urinary symptoms but who were not relieved of their symptoms. This fact alone would indicate that the presence of pyelitis at the time of

operation or before operation must have been overlooked, the inference being that this was due to insufficient study of the cases. In this group 13 patients had been operated upon, the operations having been as follows: hysterectomy and perineal repair (one patient); appendectomy and operation for duodenal adhesions (one patient); appendectomy, right ovariectomy, salpingectomy, and excision of left ovary and tube (one patient); left tube and ovary removed (one patient); right nephrectomy (one patient); gall-bladder and appendix removed (one patient); abortion (one patient); curettage (one patient); right kidney fixed (one patient); left nephrectomy (one patient); perineorhaphy and ventral suspension of uterus (one patient); appendectomy (two patients).

Group 2. The patients in this group exhibited urinary symptoms for the first time after some surgical procedure had been instituted. Assuming this to be true on account of what occurs in some of the so-called postoperative cases of pyelitis, the explanation may be summed up thus: when sufficient urinary study and data prior to operation are not at hand it is within the bounds of probability that the condition known as post-operative pyelitis is nothing else than an exacerbation of a pyelitis that was latent. Nevertheless, in this group there are cases that may be called genuine instances of postoperative pyelitis, the symptoms beginning with retention of urine necessitating catheterization. The operations after which symptons of pyelitis developed, were as follows: ectopic pregnancy (one patient); hæmorrhoidectomy (two patients); appendectomy (two patients); meatotomy (one patient); operation for hernia (one patient); right salpingo-oophorectomy (one patient); left nephrectomy (one patient); hysterectomy (one patient); perineorrhaphy (one patient).

Group 3. This group lists 65 cases that had been operated upon many years before they came under observation. A clear conception of the history of each case was sought in an endeavor to establish a connection between the operation and the development of the symptoms of pyelitis. Appended is a list of the operations which had been performed in this group:

17 on the vagina
16 appendectomies
15 tonsillectomies
10 on the rectum
8 on the ovary
4 on the gall-bladder
4 for adenoids
4 panhysterectomies
3 leg operations
3 on the eye
3 for hernia
2 on the bladder
2 for goiter
2 abortions
2 for fibroids
1 on the ureter
1 cæsarean section
1 urethral stricture
1 for tuberculous glands
1 for cyst of the cheek
1 epididymectomy
1 on the bowel
1 for tumor of the breast

Group 4. In 7 cases, or 3½ per cent, kidney operations had been done; nephropexy (one case); partial resection of the kidney 35 years before (one case); perinephritic abscess drained (one case); nephrectomy (4 cases). Subsequent infection occurred in the remaining kidney in the nephrectomized cases, on account of which there was little choice in the matter of treatment. All 4 cases responded to pelvic lavage. It would be well to remark here that when treatment other than surgical is offered this class of patients, gratitude is expressed. Although in 2 of these cases a rather well-developed hydronephrosis was present, pelvic lavage was the only treatment which could be considered. In each of these cases, when discharged from the hospital, the urine was sterile and free of pus.

TREATMENT

In cases of acute colon bacillus pyelitis, instrumental or local treatment was not resorted to. The one exception to this rule was the acute pyelitis or pyelonephrosis which occurs during pregnancy. Although this group of patients was given the benefit of internal treatment before pelvic lavage was instituted, our experience taught us that such cases do not respond to internal treatment, hence internal treatment was not continued beyond the point of safety.

The treatment of the chronic cases of pyelitis may be considered under the following heads: (1) vaccine therapy, (2) medical treatment, and (3) pelvic lavage.

Many of the cases had been through thorough and long courses of vaccine treatment, both stock and autogenous, prior to coming under observation, with negative results. Early in this work the vaccines were used in conjunction with other forms of treatment, but it soon became evident that they were not

of great value in carrying out the treatment, hence their use was discontinued. In none of the cases was the vaccine entirely relied upon, this method being used in conjunction with internal and local treatment. Since discontinuing the use of vaccines, the results obtained have been just as satisfactory as they were when both vaccines and lavage were used; hence, at present the use of vaccines does not enter into the routine treatment.

Internal treatment. Various drugs have been used and recommended, but we rely chiefly on the use of alkalies, acids, and urotropin. These are administered for periods of a week. We usually commence with the internal administration of soda bicarbonate in doses of a teaspoonful in a full glass of water, three times a day. Occasionally there are patients who have been unable to take soda bicarbonate for various reasons and in such cases resort to the use of other drugs, such as citrate of potash or citrate of soda. Enough of the drug is given to render the urine distinctly alkaline to litmus and the patients are instructed to test the reaction of their urine several times a day. After the patient has been on this regimen for a week, the alkalies are discontinued and urotropin is given. As a rule, patients are advised to take 10 grains of urotropin in a full glass of water four times a day. During this time they are given 10 grains of acid phosphate of sodium four times a day and are again instructed to test the reaction of the urine. If 40 grains of acid sodium phosphate per day is not enough to render the urine distinctly acid, enough is given to do so. This is done for the well-known reason that urotropin acts best in an acid media. Other drugs, such as benzoic acid, may be used.

Salol is one of the drugs that has been highly recommended and one I have occasionally used, but it should be stated in all fairness that it does not possess advantages over other forms of internal treatment.

In the acute cases of pyelitis, it may be stated that internal treatment had a certain degree of value, since these cases in our series were treated only internally and under the regimen just outlined. However, it is a well-known fact that many cases of colon bacillus pyelitis get well without medical aid, hence the value of these drugs must remain questionable. Despite the fact that the internal administration of drugs was employed as a routine, their value has seemed somewhat doubtful.

Pelvic lavage. Of the various methods of treatment at our command, undoubtedly the one that heads the list, so far as efficiency is concerned, is pelvic lavage. The question has been raised whether the desired results are produced by pelvic lavage or by instrumentation, namely ureteral catheterization. At times one sees that after a single ureteral catheterization for diagnostic purposes in patients who have a well marked infection of the renal pelves, the pyuria disappears as does the infection. This clinical observation is not a new one; it has been noted by various observers, and has been considered the strong point of argument for those who object to pelvic lavage. While it is true that occasionally these infections clear up after a single cystoscopy and ureteral catheterization, it is my opinion that this is not the only factor or that too much importance, as a therapeutic measure, should not be attached to it. These arguments may be met with the statement that in some of these cases of colon pyelitis that require a large number of instillations to obtain the desired result, the repeated passage of ureteral catheters do not render the urine free of pus and bacteria.

Various drugs have been recommended for use in pelvic lavage. Koll (7) has obtained very gratifying results by employing aluminum acetate. Recently mercurochrome has been suggested (8). The one group of agents, however, which has received the widest favor contains the drugs of the silver group. Of these, organic silver preparations, such as collargol, argyrol, cargentos, etc., have received general favor. In this series of cases I have used but one drug, namely, silver nitrate, for in the early part of this work silver nitrate was used, and because of the extremely gratifying results obtained, its use has been continued. It is not the purport of this paper to assert that silver nitrate is a specific or that it is the only drug which may or can be used. However, personal experience has shown that

it is an extremely valuable and efficacious remedy in the treatment of pyelitis.

The amount of silver nitrate used should be governed by each individual patient and depends upon the size of the renal pelvis. In the average case from 8 to 10 cubic centimeters were used. In cases in which a slight degree of dilatation of the pelvis is present, it stands to reason that larger amounts can be used. A precautionary measure to follow, and one to which we have adhered, is not to overdistend the kidney pelvis, a measure which precludes the causing of pain and renal colic.

If possible, pelvic lavage is carried out twice a week, or every five days, the treatment being continued until the urine is sterile and free of pus.

In treating cases of pyelitis in childhood, it is advisable to use a solution of silver nitrate of ½ per cent strength, the amounts used varying from 1 to 3½ cubic centimeters, and depending in part upon the size and age of the child. In adults a 2 per cent solution has been employed as a routine. This may appear to some to be rather a strong solution of silver nitrate to inject into the kidney pelvis, yet Geraghty (9) has recommended silver nitrate of the strength of 5 per cent. I have never employed solutions stronger than 2 per cent since the necessity has never presented itself. On the other hand, much weaker solutions have been recommended by some authorities.

In discussing the results it may not be amiss to consider briefly the results sought in establishing a cure. Of this series no case was considered as cured unless the urine was free of pus and the cultures remained sterile, three negative cultures being the routine. The subjective symptoms were the first to disappear and the pus next, the latter in many instances disappearing before the urine was finally free of organisms; but no case was pronounced cured because the subjective symptoms were relieved.

In analyzing this series of cases with reference to ultimate results, it was necessary to divide the cases into the following groups: (1) cases that died, (2) cases that failed to complete the treatment, (3) cases that were cured and (4) cases that were failures.

Group 1. In this series of renal infections 2 cases terminated fatally, the cause of death in each instance not being due to the pyelitis alone but to other co-existing pathological conditions. These 2 cases may briefly be mentioned.

One was a patient in a psychopathic hospital whom I saw in consultation 4 days before she died. The patient was in a very critical condition. The diagnosis was established by cystoscopy and ureteral catheterization; an instillation of silver nitrate was given but not with any hope of effecting a cure. The patient died as a result of her psychosis, the pyelitis doubtless being terminal.

The second patient suffered from a pyelitis which began in the puerperium. At the time I saw her she was suffering with severe chills, fever and sweats, associated with colon bacilli in the urine. Because colon bacilli were in the urine, it was thought advisable by her physicians to catheterize the ureters in order to differentiate between a puerperal sepsis and a severe colon pyelitis. Colon bacilli being present both in the right and left kidneys, silver nitrate was injected after the first examination and a second treatment was given a few days later. It was apparent that the patient suffered from a severe general sepsis and that the pyelitis was a secondary consideration. The autopsy showed thrombophlebitis of the iliac and femoral veins, abscess of the right ovary, acute nephritis, and pneumonia.

Group 2. This group comprises 89 cases. No cure was obtained for various reasons. Some of the patients were seen out of town, or were so situated that pelvic lavage could not be carried out. Others refused to accept this form of treatment. In the remainder of this group the treatment was instituted, but for various reasons the patients failed to co-operate or to return for further lavage. It may be possible that of this number a certain percentage have gone on to a cure, but proof of this is lacking. Lack of co-operation on the part of the patient is unfortunate, for the reason that it might give an unfair aspect to the efficacy of this treatment.

Group 3. In this group were 97 patients in whom urine, sterile and free of pus, was obtained before they were discharged from the hospital. Of this number, 85 were cured by means of pelvic lavage, being treated by injections of silver nitrate as discussed under the heading of Treatment. The number of injections necessary to obtain a cure were as follows:

	Cases
One injection	41
Two injections	11
Three injections	8
Four injections	5
Five injections	2
Six injections	1
Seven injections	1
Eight injections	2
Nine injections	1
Ten injections	1
Sixteen injections	1
Number not stated	11

The total number of cases treated by pelvic lavage was 128 and of this number 85 were discharged from the hospital with the urine sterile and free of pus, making the percentage of cases cured 66.4 per cent.

In 12 cases sterile urines were obtained without the use of routine lavage. These patients were cystoscoped and the ureters catheterized for purposes of diagnosis. Although, as a result of the examination, a diagnosis of pyelitis was made, subsequent bladder specimens showed urine sterile and free of pus.

Group 4. Twelve cases treated by pelvic lavage were not cured at the time of dismissal from the hospital. Analyzing these 12 cases we find the following interesting data: Two of the patients suffered from organic disease of the central nervous system. Both had so-called spinal cord bladders with retention of urine. In one instance the spinal cord disease was syphilitic in origin and in the other the changes in the spinal cord were secondary to pernicious anæmia. Three of the patients had large hydronephroses. Three patients suffered from chronic infections in the prostate and seminal vesicles. In two patients no apparent cause for failure could be ascertained. One patient had a hydronephrosis and diabetes. The remaining patient suffered from chronic morphinism.

ACCESSORY TREATMENT

As the work progressed it became evident that our attention must not be focused on the urinary tract alone. It soon became evident, especially in the cases that were rebellious to this form of treatment, that there were factors outside the urinary tract that were responsible, in a measure, for the failure of this treatment. In some of the cases these accessory factors were not and could not be recognized. However, in a large number of instances, additional factors were found and treated, and, as a result, progress was more rapidly made; hence, in treating these cases we do not look at them as strictly urological cases.

It is a well-recognized fact that lesions of the gastro-intestinal tract produce infections of the urinary tract. These lesions may be of two types, either so-called chronic constipation or other bowel conditions such as colitis. In eliciting the histories of these cases, one is surprised to find how frequently the patients give a history of various sorts of bowel distress. It has been our custom, upon establishing the fact that the patient had some sort of gastro-intestinal disease, to refer the case to the gastro-enterologist for appropriate gastro-enteric treatment, and we have found that this has materially hastened the patient's response to this form of treatment.

Various rectal conditions undoubtedly play a rôle in keeping up colon bacillus infections of the kidney. These rectal conditions, such as fistulæ, fissures and hæmorrhoids call for appropriate treatment.

As a part of the routine examination, careful attention must be directed to the presence of infection in the prostate and seminal vesicles. It is not uncommon to find that many of these patients suffer from co-existing infection either in the prostate or seminal vesicles, or in both; most often in both. We believe that it is just as important to treat these co-existing infections as it is to treat the pyelitis; and in some of the cases in which we have failed to obtain cures, the response to treatment has been more rapid after instituting proper treatment for the prostate and seminal vesicles. In some of the cases in which the patients have had relapses, the relapses were attributed to the co-existence of infection in the prostate and vesicles, because after treatment was directed toward the eradication of the foci of infection, the kidney condition rapidly cleared up.

Attention has likewise been directed toward the female genital organs and the patients have been directed to take douches either of soda bicarbonate or potassium permanganate solution. Certain lesions of the pelvic organs in women are doubtless responsible for

the presence of pyelitis and these, needless to say, call for appropriate surgical treatment.

In this series 5 of the cases showed lesions in the pelvic organs. The following lesions were found: Polyp of the uterus, cystocele and rectocele, polypoid growth on the left side of cervical stump; and fibroid of the uterus. Obviously, to treat a patient for pyelitis by means of pelvic lavage and to overlook the presence of a large fibroid can only result in bringing this form of treatment into disrepute.

In this series of cases there were 6 in which pelvic lavage was the only form of treatment advisable because the patients had only one kidney and this kidney showed the presence of infection, the opposite kidney having been removed previously for a surgical condition. In one case the kidney was removed because of hæmorrhage following the removal of a renal stone; one because of urinary symptoms similar to the present trouble; one for solitary cyst of the kidney; one for pyonephrosis; one for intermittent hydronephrosis; and in one case no reason was given for removal of the kidney.

In this series of cases, 14 occurred during pregnancy or the puerperium. The methods of treatment which have been advised in the treatment of this condition in pregnancy are: (1) to empty the uterus; (2) surgical removal of the kidney; (3) pelvic lavage.

The first two methods of treatment do not meet with my approval. In the majority of these cases, patients were advised to have the uterus emptied and in one instance the advice was that the infected kidney should be operated upon. The fact that we acted against this advice and that the patients were delivered of healthy children lends strong support to the use of pelvic lavage in the treatment of a pyelitis of pregnancy. When these patients were discharged from the hospital, 8 had sterile cultures and in 2 the kidneys were sterile but the bladder was positive.

While the number of cases of pyelitis of pregnancy is small, still it is quite apparent that the results justify giving this form of treatment an opportunity. If, after conscientious and prolonged trial of this method, the desired results cannot be obtained, and provided the symptoms persist, then either of the above surgical interventions may be considered.

The treatment of pyelitis of infancy and childhood has been considered in a separate paper (4).

SELECTION OF CASES FOR TREATMENT

This series of cases represents cases of so-called simple pyelitis that seemed suitable for the method of treatment described. Naturally, in selecting cases for such treatment, organic lesions of the urinary tract, which call for surgical treatment, should be excluded. It is well known that colon bacillus pyelitis may mask the presence of a renal tuberculosis and wrongly treating it by pelvic lavage is a possibility that must always be entertained. If an error is made in diagnosis, the desired result cannot be obtained and the method is discredited. The importance, therefore, of eliminating tuberculosis is obvious, and this we have done by diligent search for the tubercle bacillus in direct smears and by means of guinea-pig inoculations.

The presence of stone in the ureter and stone in the kidney has been excluded by means of the roentgen-ray. In two instances the X-rays were negative and it was assumed that the patients had a simple pyelitis. Subsequent passage of stones by the patients demonstrated the error in diagnosis. The presence of stricture of the ureter calls for appropriate treatment for the stricture.

CONCLUSIONS

1. Pelvic lavage with silver nitrate is an efficient, simple method for treating infections in the renal pelvis.

2. In this series of cases 66.4 per cent of the patients treated were finally discharged with urine sterile and free of pus.

3. In selecting cases for treatment, lesions of the urinary tract of a surgical nature must be excluded.

4. Lesions of the abdominal viscera which may be factors in contributing to relapses or rendering this treatment inefficient must be recognized and subjected to appropriate treatment.

5. Special stress must be laid upon giving the proper attention to lesions of the gastro-intestinal tract.

6. Lesions of the male and female genital tract must receive appropriate treatment.

7. Careful routine examinations of the urine in all cases of obscure abdominal pain should be made before patients are subjected to surgical operation.

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THE TREATMENT OF PERIPHERAL NERVE INJURIES[1]

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IN introducing the subject of the surgical treatment of peripheral nerve injuries I must confess to a growing optimism as regards the ability of a damaged nerve to restore itself if happily given the opportunity.

During the winter of 1918–1919, while co-operating with Lieut.-Col. F. H. Mackay, then chief of medicine in the Granville Canadian Special Hospital, Buxton, we had the opportunity of uncovering a series of 112 damaged nerves, 35 for freeing and 77 for suture. Careful records of these were kept, and they form the basis for my remarks this afternoon. The final results of all these cases are not available, as they have since scattered widely, but a sufficiently large number have been followed through to enable one to speak with some degree of assurance. The after-results were recorded by the physicians, not by the operator, whose judgment in these matters may be fallacious.

The final chapter in nerve surgery has not yet been written. Some time must elapse before the publication of reports which commissions are preparing in the various belligerent countries, but in the meantime there has come to be a fair unanimity of view among those best qualified to judge, and we were fortunate in undertaking our series at a time when we could profit by the experience of numerous observers. The teachings of Sir Berkeley Moynihan, Sir Robert Jones, and Sir Harold Stiles were especially helpful.

One need scarcely emphasize the importance of the pre-operative care of these patients; the massage and electrical treatment of paralyzed muscles to prevent degenerative changes, the mobilization of joints fixed or likely to become fixed, and not less important the careful splinting to prevent the paralyzed muscles from becoming stretched by the constant pull of their antagonists.

INDICATIONS FOR OPERATIVE INTERVENTION

Of the numbers of nerve wounds which were under observation during the period of which I speak, not more than one in four was referred for operation. The great majority, including some which at first suggested complete interruption, recovered without interference.

The problem was to know when to undertake operative measures. These must necessarily be delayed by the presence of sepsis, and by the existence of stiffness of the joints; the former is almost certain to spell failure, and the latter becomes further aggravated during the period of enforced rest following operation. I find that our cases were explored at periods varying from less than 3 months after injury (in one case of severe causalgia) to an interval of slightly over 9 months following the receipt of the wound (disregarding a much delayed operation on a returned prisoner). The average time was 5½ months. There were operated upon during the third month after injury, 1; fourth month after

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injury, 11; fifth month after injury, 26; sixth month after injury, 40; seventh month after injury, 20; eighth month after injury, 10; ninth month after injury, 2; tenth month after injury, 1; after 2 years, 1. An iodine wash-up was employed as a routine. With the one exception noted no wound was explored before it had been healed for a period of 3 months, and in the series, only two wounds failed to heal by primary union: one curiously enough where operation was delayed for the longest period in the ordinary series, in a patient who went absent without leave immediately after operation and returned with slight infection; the second in a case of sciatic suture where a cyst was found separating the ends of the nerve. I believe that in the rare cases where these cysts are encountered, it is wiser to leave in a 24 hour rubber tissue drain; otherwise no drainage was employed.

We are justified in delaying operative measures if definite and progressive improvement is taking place, but if there is substantial evidence of serious interruption, and signs of recovery are lacking, I believe it is wise to explore with the least possible delay, provided the wound has been healed for upward of 3 months. It must be emphasized that it is impossible to distinguish for certainty by any sign or syndrome whether we are dealing with a transitory or a permanent block.

An operation undertaken by skilled hands can do no harm, will yield information as to the exact nature of the lesion obtainable in no other way, and may result in lasting benefit. The operator must have a thorough knowledge of anatomy; branches will often be conserved by knowing where they are to be expected. Conversely, branches have sometimes been sacrificed where zeal went before knowledge. Ample assistance is a prerequisite. The nerve is best approached by generous incisions through normal tissue above and below the scar, and must be handled with a minimum of trauma. Absolute asepsis should be maintained and thorough hæmostasis. A tourniquet is better dispensed with, if it is possible to do so, as the subsequent oozing is thereby lessened.

NEUROLYSIS

Some observers, including Delagenière, have not been enthusiastic about neurolysis, or nerve freeing. Most of our cases of freeing have given satisfactory and some of them most gratifying results: in one case where the median was involved in a dense scar in the lower axilla, freeing relieved the causalgia from which he was suffering and restored flexion to the index finger and thumb within 5 weeks of operation.

In another instance where the median and ulnar were both involved in dense scar under the pectoralis major, the causalgia was immediately relieved and the circulation in the hand greatly improved; the sensory and motor paralysis disappeared by the end of the ninth week.

One case of interest concerned an individual who had been taken prisoner and had undergone in Germany an operation for suture of the sciatic some 2 years previously with partial success, inasmuch as he had limited voluntary power in the calf muscles. The nerve was cut down upon, and was found throttled in the grasp of a fascial wrap, involving especially the lateral half. When this was removed by careful dissection the nerve had a look of promise about the suture line, and was not further disturbed. Within 7 weeks he had definite voluntary power in the tibialis anticus, with marked increase of power in the flexors, and an obstinate trophic ulcer on the great toe of 2 years' standing had completely healed.

One median nerve, which gave evidence of a complete lesion in the mid forearm, when freed from 2 inches of scar tissue, was found to present two small interstitial neuromata the size of a split pea. Stimulation by weak faradism gave a limited response, and as the nerve otherwise felt soft and uniform the wound was closed. The case markedly improved, and within 5 weeks had a return of power and a marked decrease in the area of analgesia and anæsthesia.

Contrary to expectations a previous ligation of the axillary artery proved no bar to a good result after extensive freeing of the cords of the brachial plexus in what had clinically appeared to be a severe lesion. Within 9

weeks the motor paralysis had almost completely disappeared. In another case presenting a large aneurismal varix of the axillary artery, where I was able to excise the vein and suture the wound in the artery, the cords were firmly matted in scar tissue sufficient to lead to a clinical diagnosis of complete interruption of the ulnar and musculospiral. It was found possible to do a satisfactory freeing, and the patient made a most gratifying recovery, having the return of full function in less than 4 months.

Freeing is justifiable if it restores a nerve that is fairly uniform, soft, and supple, especially if a response is given to weak faradism, but the absence of the latter does not necessarily mean resection and suture. The interstitial neuroma presents a special problem, and each case for and against section must be weighed on its merits. The dictum of Tinel that "a good suture is far better than a bad liberation" is worthy of more than passing notice.

NERVE SUTURE

The recovery after suture is necessarily slower than after freeing, but our results have been on the whole most encouraging. Some if not worthy to be described as perfect fall not far short. One case of suture of the musculospiral, well above the elbow, where the distal end was found greatly diminished in size, was able within 2 months to extend the wrist. This man, with the gratitude of the patient in the scriptures who was contrasted with the remaining nine, hunted me up on my return to Canada 6½ months after the operation, to show me an arm which he proved was in all respects as good as its fellow.

I have seen complete successes in the median, both above and below the elbow. The ulnar nerve is perhaps less satisfactory, especially as regards the return of power in the interossei, but some cases have shown excellent recoveries. One ulnar nerve from which 2 inches were resected immediately above the elbow was examined 72 days after operation by Mackay, who made the following report: "Now has full voluntary power in interossei; this has been a remarkably excellent result in a short time." Another ulnar nerve sutured in the mid forearm had definite voluntary power in the interossei on the sixty-seventh day following operation.

The method of suture we employed is not new. In a recent retrospect of the surgery of the peripheral nerves, I took occasion to say that the advice of the twenty-year-old edition of that most excellent textbook of surgery by Rose and Carless holds true today. I quoted: "Suture is best accomplished by using a domestic sewing needle without cutting edges . . . and the finest chromicized catgut. One or more stitches should pass through the nerve, and the rest merely through the sheath. Absolute asepsis is essential in order to obtain satisfactory results." With the omission of the word chromicized as Mr. Carless has done in later editions, the truth could not be better told.

Fascial wraps were not used. As far as possible the suture line was left in its natural site, i.e., in an intermuscular or subcutaneous plane. The divided ends were freshened to provide healthy fibers, and although in some cases this meant a gap of 3 or 4 inches, *in no case of the series* was it found necessary to resort to nerve grafting. In three cases of injury to the musculospiral nerve at the elbow, it was impossible to find the distal motor nerve (posterior interosseous), and a subsequent tendon transplant was advised, a procedure which gives excellent functional results. Apart from these, end-to-end suture was accomplished in every case, by free exposure of the nerve, by stretching before the bulbs were sectioned, by posture, sometimes by alteration of the course of the nerve to provide a shorter route.

In one ulnar lesion in the mid forearm where it was obvious that the gap would be insurmountable, the freed bulbs were approximated by a stout chromicized catgut suture with the wrist in acute flexion, it being gradually extended during the following fortnight. This man had a convenient tattoo mark on his forearm, representing "Buffalo Bill," and it was noted that the suture was exactly opposite the necktie. After a month the bulbs were again cut down upon, the ends freshened, and approximated with a minimum of trouble. Five weeks later there was marked recovery in sensation and there was slight but definite

power of adduction in the little finger, absolute evidence of regeneration. I believe this procedure to be a sound one and well worthy of employment.

While undue tension is to be avoided, moderate tension does not seem to be a deterrent to regeneration, provided it is not sufficient to tear the suture line apart. In fact in many of our striking successes the operation report comments on the tension of the nerve. On the contrary, jamming of the ends together is undoubtedly a cause of failure. I further believe that every effort should be made to prevent torsion of the nerve.

Some time ago I had a letter from Dr. Gallie of Toronto saying one of our cases had been referred to him, showing remarkable recovery of both median and ulnar nerves. On looking up the records I found he had had an end-to-end suture of both nerves in the upper arm less than 8 months previously, and that at the time of his original injury the brachial artery had been tied. This corresponds with the successful neurolysis case where the axillary artery had been severed.

Some of our cases presented opportunities for what may be termed conservative suturing, and from results obtained I believe this is sometimes justifiable. In the larger trunks, as for instance the sciatic, it may be found that the lesion is confined to one portion of the nerve. In such a case it is simple to split the nerve longitudinally, removing the damaged portion and suturing the ends, leaving the undamaged portion looped upon itself. But this method may also be applicable in a smaller nerve—thus in one instance we uncovered a partial lesion of the median nerve above the elbow in which there was some voluntary flexion in the fingers, but none in the thumb; there was no loss of sensation, rather a hyperalgesia over the median area, and severe causalgia was associated. At operation the nerve was found involved in a very dense scar, and when freed presented a lacerated and irregular appearance in the lateral half, with good fibers in the remainder. Stimulation gave a partial response in the fingers but none in the thumb. One hesitated to sacrifice the part that was functioning, so the nerve was split longitudinally and the ends of the half-nerve sutured after excision of the damaged portion. Mackay's report some 6 weeks later reads: "There is a very marked improvement in this case: flexion is now present in all phalangeal joints; distal phalanx of thumb can be strongly flexed, and index finger flexed at all joints; sensation normal all over hand; atrophy as before: there is much less fibrosis of hand, and patient should get full recovery."

Several of the musculospiral injuries were associated with fractures of the humerus, where the nerve was involved in the callus. The most instructive complication of a fracture was in a patient, who, on receiving a bullet wound through the knee, had fallen, causing a transverse break of the femur in the middle third. He was admitted to us for a complete external popliteal lesion, with the femur well united, but with some 3 inches of overriding. We explored at the level of the bullet wound, to find the nerve intact. Continuing the incision upward, we found that in falling, the femur must have telescoped a further 3 inches to cause a complete division of the nerve some *6 inches* below the fracture line.

Perhaps the most unusual of all our cases was one in which a complete paralysis of the deltoid existed. An X-ray of the shoulder revealed a very small foreign body, just posterior to the surgical neck of the humerus. Mackay suggested that this small fragment had divided the circumflex nerve, and advised exploration. At operation it was found that the fragment had severed the nerve just at the point of its bifurcation. By good fortune the distal ends were secured in the substance of the deltoid and the proximal end was identified coming through the quadrilateral space. The ends were very small and could not be sutured in the established method, but they were anchored together and a measure of continuity restored. On the twenty-ninth day he was found to have voluntary power in the muscle, and within 5 weeks the deltoid had sufficiently recovered to hold the arm at right angles against gravity. The rapidity of the recovery is not to be wondered at when one realizes the short distance the regenerative process once established had to travel.

It may be of interest to refer in passing to a sciatic lesion from which there was considerable causalgia. In cutting down on the nerve one-half was found completely divided and presenting a large proximal bulb. In the remaining half a hard mass was encountered, which proved on section to be true bone, extending over 2 inches along the course of the nerve. This was excised and an end-to-end suture was performed. As every effort to find evidence of a fracture or bony injury was unavailing, one was forced to look upon the process as an unusual example of metaplasia. An X-ray of the specimen, after removal, revealed clearly the curious contour of the newly formed bone.

Time does not permit more than a passing reference to after-treatment; massage and galvanism are probably of value; careful splinting to maintain the paralyzed muscles in relaxation is indispensable. When recovery is sufficiently advanced, re-education by purposeful movements is of prime importance, and the various forms of apparatus so essential at first should be dispensed with at the earliest possible date.

In nerve surgery one must guard against impatience; nerve growth is an extremely deliberate process. One of our patients reported recently with a regenerated musculospiral in whom a tendon transplant was done some 7 months after the nerve was sutured. In our series we saw no results which may be described as phenomenal or which would lead us to think that regeneration in the sutured nerve proceeds in other than an orderly way. As I said at the outset our results have made me optimistic on the subject; nature's healing power never seems more wonderful than when one is permitted to see paralyzed muscles regaining their power, impaired sensation being restored, and trophic changes disappearing in an extremity, following upon the effective restoration of conductivity to a damaged nerve.

THE DIAGNOSIS OF PERIPHERAL NERVE LESIONS

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THE conclusions which I wish to present in this paper are based on the examination of over 600 cases of peripheral nerve injuries, treated at the Granville Canadian Special Hospital, Buxton, Derbyshire. This hospital was specially instituted for the treatment of nerve lesions, and as all observations were directed toward the purely clinical aspect of the problem, I shall attempt to discuss only the clinical findings and their bearing on diagnosis.

To one whose attention is confined to clinical problems and whose primary objective is to decide on the necessity of operation, I think little opportunity for the study of physiological problems is given, and any conclusion arrived at must necessarily be of little consideration to the physiologist. In the first place, we were dealing with war wounds, often with badly lacerated tissues, and always with men, who withstood the hardships and emotions incident upon war-zone experience for months and years. To attempt physiological investigation in such patients, with their shattered nervous systems and ill-controlled emotions, whose only concern was their early return to Canada, would lead to conclusions, which, I fear, would not be accepted by the physiologist.

On the other hand, the opportunity for clinical investigation has been great and if, in this field, our observations fail to uphold the teachings of former or even contemporary workers, we are, I believe, justified in discarding such tenets from our diagnostic armarium.

Armed with the accepted teachings on nerve phenomena, anatomical and physiological, and confident that all nerve lesions could be placed under one of the several syndromes formulated by the continental writers, we approached the problem with an easy mind, but in a very few months we learned that no such easy classification was possible, and that the general clinical picture offered a surer guide to a correct opinion than any effort to fit the signs of each case into a definite nerve syndrome.

In studying nerve regeneration, whether spontaneous or following nerve suture, we also found that complete adherence to formulated schemes and accepted teachings led us far afield.

Our first problem was to decide whether we were dealing with a complete or partial lesion, and given several examinations, which followed each other at ten-day intervals, and a due regard for the many deceptive factors which invariably arise, this was not always difficult. To decide, however, when dealing with a complete lesion, whether it is due to anatomical or physiological interruption, was a very different matter and I know of no scheme whereby this differentiation can be definitely made, other than by direct observation at operation.

Innumerable signs and phenomena have been recorded to assist in a reasonable forecast as to the possibility of spontaneous regeneration, but unfortunately many, or I may say, most of these have proved fallacious and on this occasion I propose to discuss these signs and the assistance they may have been to us in this work.

Dealing, primarily, with motor phenomena, one is surprised to learn how frequently muscles, which were formerly considered the sole means of certain joint or bone segment movement, may be supplanted in their function by other muscles or tensions, and how often attitude of the limb may lead to erroneous conclusions.

Accepting as our standard of function the movement of a joint segment, there are very few exceptions to the rule that these movements may be substituted by other muscles or tensions, and these exceptions comprise our sole means of differentiating a complete lesion from an incomplete.

In the case of the musculospiral nerve, I believe that inability to extend the terminal

[1] Read before the Clinical Congress of American College of Surgeons, Montreal, October 14, 1920.

phalanx of the thumb is a certain indication of complete loss of function in that nerve. Apparent extension of this phalanx is possible, but in all cases is, I believe, due to the synergic action of the flexors, whereby the segment is primarily flexed under tension, which flexor movement is followed by secondary rebound, simulating weak extension. And this is true of all segments under the control of synergically acting muscles. When voluntary movement is attempted by a paralyzed group of muscles, the antagonistic muscles are overcontracted and the rebound from this overtension simulates movement of the segment in the direction of the paralyzed muscle. If this is understood and guarded against, extension of the distal phalanx of the thumb is never observed in a completely paralyzed musculospiral nerve.

Slight extension of the proximal phalanges of the fingers may be apparent if the hand is allowed to be flexed at the wrist, resulting in undue tension on the extensor tendons, by this time sclerosed and shortened to a degree not possible in health, but this may be guarded against by placing the palm in line with the forearm on a flat table, the fingers being flexed at the metacarpophalangeal joints to a right angle and hanging over the edge. Under these conditions, extension of the finger at the metacarpophalangeal joints is impossible if the musculospiral nerve is completely paralyzed. Extension at the wrist-joint is frequently simulated if the fingers are strongly flexed, thereby setting up tension on the dead extensor tendons of the fingers, which results in passive extension at the wrist.

Adduction and abduction of the hand, at the wrist-joint, is undoubtedly possible in cases of complete musculospiral paralysis, notwithstanding many statements to the contrary. That these movements are affected by the flexor carpi radialis and the flexor carpi ulnaris, respectively, is shown by the noticeable degree of flexion that accompanies them.

In considering the median and ulnar nerves, one must first recognize the close relation between the functions of these structures, particularly in regard to their distribution. There is little doubt that one continually meets with irregularities and overlapping, both in their motor and sensory distribution, and this particularly applies to the innervation of the lumbricals and flexors of the fingers. Quite frequently, one observes full flexion of the middle finger in complete median lesions, which must be explained by partial ulnar supply to the flexor sublimus and, in some cases, ulnar innervation of the flexor profundus to that digit. Flexion of the terminal phalanx of the thumb is sometimes simulated by rebound, following contraction of the extensor longus pollicis.

The only irrefutable sign of complete median lesion is the loss of flexion of the two terminal phalanges of the index finger, which movement cannot be supplemented in absence of median innervation.

We have never encountered any evidence to disprove the innervation of the interossei by the ulnar nerve alone, and as the function of these muscles in health is to adduct and abduct the fingers, to extend the two distal phalanges of all the fingers and, in conjunction with the lumbricals, to flex the proximal phalanges, one would expect that all these functions would be lost in complete lesion of the ulnar nerve. As a matter of fact, extension does take place in the terminal phalanges, probably by contraction of the extensor communis digitorum exerting tension on these distal segments through the paralyzed and lifeless bellies of the dorsal interossei, which now act as connecting fibrous structures only. Lateral movement of the fingers, especially in the index and little fingers, is sometimes observed in complete lesions of the ulnar, but is always combined with simultaneous extensor movement, indicating a supplementary action of the extensor communis digitorum. If the hand is placed on a flat surface and the fingers maintained in line with the palm, lateral movement of the fingers is impossible in complete ulnar lesion.

In injuries of the sciatic nerve, like difficulties are rarely met with. Dorsi-extension of the foot, at the ankle-joint, may occur if the toes are strongly flexed at the same time, thereby exerting tension on the paralyzed extensors of the toes. If this movement is

guarded against, extension of the foot does not occur if the external popliteal is divided, nor can eversion of the foot occur, except when there is some degree of function in the external popliteal nerve.

One must therefore conclude that simple movement of a joint segment does not always indicate integrity of the nerve of supply, while, on the other hand, complete loss of voluntary power, at one or two examinations, may not bespeak complete physiological interruption. This is especially observed in nerves, whose constitution is predominantly motor, such as the musculospiral and the peroneal branch of the external popliteal. In these nerves slight injuries may set up apparently complete paralysis in the muscles supplied, lasting for several weeks and terminating in spontaneous recovery. In such cases, it may be assumed that there is an associated functional paralysis, which tends to perpetuate the original organic disability, and this is given support by the frequent necessity of inaugurating movement by some form of persuasion.

Loss or diminution of the various forms of sensation is generally considered a fair index to the degree of nerve injury, but, in our cases, we found that neither the extent nor degree of disturbed sensation offered a reliable indication of the condition of the nerve. The extent of loss of cutaneous sensibility varied so much in different lesions, proved, later, to be totally interrupted, that we could no longer regard it as unassailable evidence of nerve destruction or integrity. In complete ulnar lesions, the loss might involve the whole anatomical distribution of this nerve, or only the palmar and dorsal surfaces of the little finger, more frequently extending just below the root of this digit. Totally interrupted median lesions, likewise, might show sensory change over the first three fingers and entire median area of the palm, while, in other cases, the loss might be confined to the index finger alone. Complete division of the musculospiral, above the origin of the radial branch, is frequently unaccompanied by cutaneous loss.

This variation in extent of sensory loss applies to all the peripheral nerves and must be explained by overlapping of adjacent nerve terminals or, in some instances, by anastomosis with adjacent nerve trunks.

Careful examination of all forms of cutaneous and deep loss was made, including pain, touch, temperature, pressure, position and vibration sense, and an effort made to map out different zones for each of these forms of sensation. It must, here, be stated that no mechanical gradation of stimulus was made, our technique consisting in the use of a pin for pain, camel's hair brush or cotton wool for touch, and test tubes containing water at 22° C. and 50° C. In cases where the extremity was cold, it was immersed in warm water at about 35° C. before examination was undertaken, as it was found that reliable results could not be obtained in a cold limb.

Schooled in the doctrine of epicritic and protopathic systems of sensory innervation, we endeavored to outline two zones, an inner, where all forms of sensation were lost, and an outer, where only touch and finer discrimination were missing; but invariably failed to satisfy ourselves that such definite line of demarcation could be drawn.

Our first procedure was to outline carefully the area of loss to cotton wool (light tactile sensation), and secondly that of pin prick (pain). With heavy prick one could locate an area, centrally or distally placed as the case might be, of total anæsthesia. Then with moderate prick, a larger area surrounding this and, finally, by very light prick this area could invariably be extended to coincide with the area of anæsthesia to cotton wool, previously mapped out, so that it was theoretically possible to outline various concentric zones, corresponding to the degree of force used in manipulating the pin. Our experience was that the areas of loss to cotton wool and loss to light pin prick were identical, so that we came to rely, for all practical purposes, on the use of light pin prick, while, at the same time our belief in two separate and distinct systems for cutaneous sensation, one, the epicritic, underlying light touch and the other, the protopathic, underlying pain, could not be reconciled with our findings.

Loss to temperature sense, as interpreted from the use of test tubes, containing water at about 50° C. and 22° C., was so variable as

to be of little practical use, but roughly corresponded with the area of loss to light touch and light prick.

Loss of deep sensation, for pressure, vibration and joint movement, generally involved an area much in excess of the cutaneous loss and gave little or no information of value to the clinician.

Variation in the extent of cutaneous loss, from day to day, suggests a partial lesion or a superadded hysterical disability, while constant adherence to the original limits, however limited or extensive, bespeaks a complete physiological lesion.

From a consideration of the electrical reactions, alone, we obtained little information of prognostic value, while from the standpoint of diagnosis, its most useful application was in differentiating functional paralysis. Very slight organic lesions, which began to show regeneration in 3 to 5 months under nutritional treatment, were almost always accompanied by early loss of faradic stimulation, while severe lesions showed loss to faradism throughout the entire period of regeneration, this being the last factor to return. In our experience, return of faradic excitability was invariably preceded by return of voluntary power and frequently by return of "pin-prick" sensation. The type of response to the galvanic stimulus was of considerably more value in diagnosis. The slow, sluggish response, with retarded relaxation, indicated a severe lesion and was the most reliable index to the reaction of degeneration at our disposal.

Polar changes, as evidence of complete reaction of degeneration, were found unreliable and were early discarded for the use of condensor shocks, applied to the galvanic current. For this purpose, use was made of the Lewis Jones condenser, which, in the hands of some workers, appeared to be of value in denoting regeneration, some even basing their prognosis on the number of micro-farads necessary to set up contraction. Here, too, we met with disappointment, as it was found that changes in muscle excitability, as registered by this apparatus, were frequently misleading.

Frequently we have noted improvement in the condition of the muscle under nutritional treatment, as reflected in the number of micro-farads necessary to produce response, advancing from 2.0 micro-farads, at first examination, to 0.5 or even 0.33 micro-farads, in the course of a month or 6 weeks, only to find at operation that we were dealing with a complete lesion, presenting well formed bulbs at both proximal and peripheral ends. Repeated similar disclosures have shown us that improvement in the muscle belly does not run hand in hand with regeneration of the nerve.

The most reliable sign of complete or severe lesion is the replacement of the quick, flash-like response to galvanic stimulation by the slow, retarded relaxation, always, of course, accompanied by faradic inexcitability and, provided the muscles are maintained in good condition, we have never noted a complete disappearance of this reaction, during the period of time over which we were able to observe our cases, often amounting to 8 or 10 months from date of wound.

The so-called longitudinal reaction of Huet, though looked for, was seldom observed and, when so, was an accompaniment only of the characteristic galvanic response.

Erb's paradoxical reaction, viz., faradic excitability of the muscle or nerve below the lesion, while stimulation above the lesion fails to give response, indicates a partial and local lesion from which spontaneous recovery may be expected, but as it is applicable only to nerves, which, at some point, run a superficial course, its value in diagnosis is extremely limited.

Muscle atrophy, as an indication of the severity of the lesion, is of little clinical value as the most severe degrees of wasting are often observed in partial lesions and, in fact, appear to be more rapid in onset. Atrophy is always more apparent in its onset and extent in the smaller muscles, as is so often seen in partial lesions of the ulnar nerve, which have been allowed to rest for a week or two. In some of these cases, the extreme degree of wasting in the interossei and hypothenars suggests that we are dealing with a much more severe, if not complete lesion of the nerve. Atrophy would appear to depend solely on the nutritional and manipulative treatment, while

disuse of the limb or absence of manipulation engenders severe wasting of, not only the muscles, but also the underlying bone segments; witness the degree of bone atrophy, especially in the phalanges, which accompanies hysterical paralysis.

The same observation may be made in regard to trophic disturbance and on this point, we are in complete accord with Tinel and others, that the most extreme trophic disturbances accompany partial lesions, especially those of the irritative type. If any conclusion may be drawn from the evidence of trophic loss, it is that, with severe trophic change, we are dealing with an incomplete lesion of the nerve.

We have never been able to make any diagnostic use of the presence or absence of pain in the muscle bellies, as pain to pressure may be encountered in complete lesion of the nerve and is by no means a constant accompaniment of incomplete ones.

Formication over the distribution of a nerve, set up by pressure below the lesion, applies only in cases, in which the nerve trunk runs a superficial course, such as the ulnar and external popliteal and, when present, is a valuable indication of a recovering nerve. It is, however, an infrequent accompaniment of regeneration as it has been observed in a very small proportion of ulnar and external popliteal lesions.

A review, therefore, of the various signs would appear to produce few absolute and irrefutable indications of the condition of the nerve and, after all, one's diagnosis is practically a differentiation of the complete from the partial lesions.

Clinically, there is no advantage in pigeonholing each lesion under one or another syndrome, even if this were possible, but a reasonable opinion as to the integrity of the nerve should be possible from the general clinical picture.

The decision that a nerve is completely injured implies only physiological interruption, as, beyond the discovery of palpable end bulbs, there are no signs by which anatomical and physiological lesions may be differentiated.

Of all the signs, assigned to nerve injury, we consider that the presence or absence of true voluntary motor power offers the most valuable guide to an opinion, and while there are many pitfalls in the interpretation of motor power, chief among which are the supplementary movements, these, if recognized, should offer little difficulty.

The unmistakable return of voluntary power in a muscle, which, at first, may manifest itself in weak fibrillary contractions, is the surest and most frequent sign of a recovering nerve, and this nerve may now be treated under postural and nutritional conditions to a finality. If in three months following injury there is no perceptible voluntary movement, we are of the opinion that an exploratory operation is indicated and seldom has operation, under such conditions, been unnecessarily performed.

In recognizing, as we do, the impossibility of diagnosing the anatomical condition of the nerve and, in limiting our decision to that of physiological interruption, we have met with many cases, where uncertainty featured the diagnosis and, in these cases, time can be saved for both patient and staff by operation and direct inspection of the nerve, which procedure, in the hands of skilled operators, is not only safe and rational, but in many cases enhances the chance and rapidity of recovery to a considerable degree.

PRE-OPERATIVE PREPARATION OF PATIENTS WITH OBSTRUCTIVE JAUNDICE

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THE fact that jaundiced patients bleed too freely following operation has been known for several years, and in the absence of exact criteria many surgeons have looked for one or another clinical sign for an index to the severity of the operative risk. Some surgeons believe that purpuric spots on the patient with obstructive jaundice are advance agents of death in case of operation; others believe that a blood coagulation time of more than 9 minutes is a contra-indication to operation, and still others that dehydration with marked jaundice persisting more than 2 or 3 weeks is a contra-indication. Further, there is no doubt that many cases of cholelithiasis and stones in the common duct have been diagnosed as malignant disease and the patients have been returned to a life of invalidism, since the surgeon did not wish to do an abdominal exploration because, in the presence of jaundice, it seemed to entail grave risk.

This study was made for the purpose of investigating the reason for the high mortality following operations on patients who have obstructive jaundice. The reports of patients from the records of the Mayo Clinic during 1918, 1919, and 1920, who had obstructive jaundice at the time of operation and who have died, were reviewed in order to determine the cause of death and the relation of such cause to the degree of jaundice and the coagulation time of the venous blood. Only cases in which coagulation time estimations had been made were tabulated.

In Table I a comparison is shown between the findings at necropsy in 29 patients with obstructive jaundice at the time of operation who died subsequently, and in 34 patients who were without jaundice at the time of operation who died. It is of interest to note that 15, more than 50 per cent, of the patients with jaundice died from intra-abdominal hæmorrhage, or at least had a large amount of blood in the peritoneal cavity, while but 6 per cent of those without jaundice died from intra-abdominal hæmorrhage.

Table II shows the degree of jaundice, coagulation time, and operative procedures on the 15 jaundiced patients who died from postoperative hæmorrhage. In 11 of the 15 patients (73 per cent) the coagulation time was more than 9 minutes. In 10 (66 per cent) the jaundice was graded 3 or 4 on a scale of 1, 2, 3, 4.

It is noteworthy that in all cases death occurred from 1 to 7 days after operation, as may be expected if continuous oozing is taking place. If the cystic artery or one of its branches were the cause, death might be expected immediately following operation. At necropsy in every instance the exact source of the hæmorrhage could not be found.

In order to determine whether deaths from hæmorrhage were dependent on an elevated coagulation time and marked jaundice, a study was made of the case histories of 14 patients, the only patients in whom comparisons had been made of the coagulation time and degree of jaundice, who were jaundiced at the time of operation on the bile tract, and who died from causes other than postoperative abdominal hæmorrhage. It was found that but 3 had had a coagulation time of more than 9 minutes and 5, jaundice graded 3 or 4 (Table III). Only 2 of the 14 had had cholecystectomies, the others some type of drainage operation on the bile-ducts.

TABLE I.—Findings at Necropsy in Patients Operated on for Lesions of the Gall-Bladder.

	With jaundice	Without jaundice
Patients	29	34
Cause of death		
Postoperative hæmorrhage	16	2
Peritonitis	3	5
Bronchopneumonia	3	4
Pulmonary embolism		6
Cerebral embolism		1
Ileus		3

TABLE II.— FIFTEEN JAUNDICED PATIENTS DYING FROM POSTOPERATIVE (INTRA-ABDOMINAL) HÆMORRHAGE

Case	Age	Degree of jaundice	Degree of bile	Coagulation time, minutes	Calcium time, minutes	Operation
341399	39	4	1	10	10	Choledochotomy; cholecystectomy
255676	48	2		23	28	Choledochotomy; cholecystectomy
209163	34	2	2	8		Dilation of stricture; choledochotomy
210429	48	4	3	14½		Choledochotomy
197147	37	4	4	13		Cholecystostomy
335327	50	3	2	15	11	Exploration
200538	43	3	2	8		Exploration
241960	53	2	2	20		Cholecystectomy; choledochotomy
235723	48	4	3	16		Dilation of stricture; choledochotomy
231348	64	2	1	10	12½	Cholecystectomy; choledochotomy
226821	65	4	2	6	17	Cholecystostomy; choledochotomy
262802	29	4	3	36	35	Dilation of common duct
267424	57	3		10	9	Cholecystectomy. Removal of stones
271933	39	4	2	17	14	Choledochotomy
328617	47	1	1	7½		Cholecystectomy. Closure of gall-bladder fistula

Coagulation time more than 9 minutes in 11 of 15 patients. In 10 of 15 patients the jaundice was graded 3 or 4.

These facts presented in Tables II and III seem to be direct evidence that the cause of death of most of the patients with obstructive jaundice was postoperative intra-abdominal hæmorrhage, which seemed to be due to a continual oozing from traumatized surfaces rather than bleeding from severed arteries. The corollary of this is that in deeply jaundiced patients the tissues should be handled with the utmost care and gentleness and oozing from the liver surface prevented by refraining from doing a cholecystectomy until the jaundice has subsided.

Two methods of determining the coagulation time of the blood are used in the Mayo Clinic: Boggs' method, in which estimation is made by the time required for blood from a stab wound in the ear to coagulate, and the method described by Lee and White, in which the coagulation time is determined by the time it takes for 1 cubic centimeter of blood withdrawn from a vein to coagulate. The blood is withdrawn by a syringe and placed in a test tube, both having previously been washed with normal salt solution. The Lee and White method is preferred because in Boggs' method the true coagulation time of the blood is shortened by the combination of the juices of the tissues of the ear with the blood as has been definitely shown by Lee and White. The test of the calcium time of the blood described by Lee and Vincent is also made in the Clinic. Six drops of a 0.5 per cent solution of calcium chloride are added to 1 cubic centimeter of venous blood, and the time required for the blood and the calcium chloride to coagulate is called the calcium time of the blood. These observers have shown that when the calcium time is lower than the coagulation time of the blood the coagulation time in most instances can be lowered to approximate the calcium time by the administration of calcium lactate by mouth for a three day period. They proved that a retarded coagulation time could be produced experimentally by producing an obstructive jaundice in dogs, and that this retardation of the coagulation time appeared at the end of the fifth week of the jaundice. They were able to produce an immediate reduction in the coagulation time of these

TABLE III.— FOURTEEN JAUNDICED PATIENTS DYING FROM CAUSES OTHER THAN HÆMORRHAGE

Case	Degree of jaundice	Degree of bile	Coagulation time, minutes	Calcium time, minutes	Operation	Cause of death
327611	2	2	5	8	Cholecystogastrostomy	Suppression of urine
306039	4	3	6	9	Cholecystostomy; choledochotomy	Bronchopneumonia
269833	3	Trace	6		Transduodenal excision of carcinoma	Peritonitis from rupture of incision
253416	1	1	10	12	Removal of specimen	Bronchopneumonia
212281	1	2	5½		Cholecystostomy; choledochotomy	Peritonitis
183889	3+	4	12	20	Hepaticoduodenostomy; exploration of ducts	Abscess of liver; purulent pericarditis
211383	1	1	11		Choledochotomy; exploration of common duct	Thrombosis of portal vein; abscess of liver
199201	4	3	9	11	Choledochotomy	Nephritis following transfusion from wrong donor
189394	2	2	6	8	Cholecystostomy	Peritonitis
192733	3	2	8		Cholecystectomy; choledochotomy	Tuberculosis; bronchopneumonia
24548	2	2	7		Cholecyctostomy; choledochotomy	Fat necrosis?
214253	2	2	7		Cholecystostomy; choledochotomy	Cholangeitis
350691	1	0	7½	4¼	Cholecystectomy	Necrosis of the head of pancreas
352666	2	+	8		Cholecystostomy	Questionable

Coagulation time more than 9 minutes in 3 of 14 patients. In 5 of 14 patients the jaundice was graded 3 or 4.

animals by intravenous injections of 2 per cent calcium lactate, such reduction being sustained for from 2 to 3 days, without deleterious effect on the general condition of the animals.

Besides lowering the coagulation time by calcium, some observers believe that calcium is beneficial in decreasing the toxicity of patients with obstructive jaundice. Among the most noteworthy theories is that of King and Stewart who believe that bile pigments in combination with calcium or with sodium are less toxic than uncombined pigments; they consider calcium a protective mechanism against circulating pigments of obstructive jaundice.

King, Bigelow, and Pearce conclude that obstructive jaundice produced in dogs results in a loss of calcium, the calcium being given up by the bone to neutralize the toxic bile pigments circulating in the blood and tissues. Such neutralization affords protection to the body, but may lead to secondary disturbances, for example bradycardia and changes in the blood coagulation time. In view of the work of these investigators the belief seems justified that calcium offers the best means of preparing jaundiced patients for operation, since it not only reduces the coagulation time of the blood, but also decreases the toxicity produced by the circulating bile pigments. We have adopted the suggestion of Lee and Vincent to use calcium intravenously. From 5 to 10 cubic centimeters of a 10 per cent solution of calcium chloride in redistilled water, which was given each of 6 patients with obstructive jaundice who had abnormally high blood coagulation times, lowered the coagulation time to normal after three injections on successive days. In addition 4 of these patients were given calcium lactate by mouth in doses of 100 grains daily (Table IV).

Recently Grove and Vines have stated that they have proved experimentally that calcium salts given by mouth have no influence on the blood calcium, in which case the administration of calcium intravenously is the method of choice, since the calcium not only lowers the coagulation time of the blood, but also combines with the bile pigments circulating in the blood stream.

That the intravenous injection of calcium in small doses is not a harmful procedure has

TABLE IV.— THE EFFECT OF PRE-OPERATIVE PREPARATION ON THE COAGULATION TIME OF VENOUS BLOOD IN PATIENTS WITH OBSTRUCTIVE JAUNDICE

Case	Age	Degree of jaundice	Degree of bile	Coagulation time, minutes	Calcium time, minutes	Coagulation time after preparation, minutes	Preparation
352536 H.H.E.	54	4	3	16	12	9¼	5 ccm. 10% calcium chloride intravenously, daily, 3 days 100 gr. calcium lactate daily, 4 days Carbohydrate diet 4000 ccm. water daily
339670 M.	55	3	3	14	9	2*	5 ccm. 10% calcium chloride, intravenously, daily, 2 days 100 gr. calcium lactate daily, 4 days Carbohydrate diet 3% glucose solution proctoclysis 4000 ccm. water daily
353678 J.F.W.	55	4	2	16		5**	100 gr. calcium lactate daily, 5 days Carbohydrate diet 3% glucose solution proctoclysis 4000 ccm. water daily
357387 J.L.T.	60	4	4	12 (5/6/21)	12 (5/6/21)	6 (5/17/21)	5 ccm. 10% calcium chloride intravenously, daily, 3 days 100 gr. calcium lactate daily, 5 days 15% glucose solution proctoclysis 4000 ccm. water daily
357833 L.B.	46	4	4	5½ (5/14/21)	5½	4 (5/16/21)	5 ccm. 10% calcium lactate intravenously, daily, 2 days 100 gr. calcium lactate daily, 4 days Glucose solution proctoclysis 4000 ccm. water daily, 4 days
369429 C.C.T.***	37	4	4	9	12	2	5 ccm. 10% calcium chloride intravenously, daily, 3 days 10% glucose solution proctoclysis 4000 ccm. water daily Carbohydrate diet
286431 F.F.	50	4	4	6	2	2	5 ccm. 10% calcium chloride intravenously, daily, 3 days 10% glucose proctoclysis 4000 ccm. water daily Carbohydrate diet

*Twenty-two days after operation the coagulation time was 5 minutes and 15 seconds. The jaundice was greatly decreased.
**Fifteen days after operation coagulation time was 3 minutes, 40 seconds; marked diminution in jaundice. Thirty days after operation coagulation time was 5½ minutes.
***Patient had bleeding gums, petechia, and subcutaneous hæmorrhages which began to disappear after the intravenous injections of calcium, and did not reappear.

been proved (Lee and Vincent). Cambell has given calcium acetyl salicylate to 55 patients in doses of 0.5 grams in 10 cubic centimeters of distilled water (a concentration similar to our calcium chloride solution) at three day intervals, in some cases as many as seven injections for relief of neuralgias and myalgias. This emphasizes the fact that calcium in small doses may be given intravenously without deleterious effect. I have given 10 cubic centimeters of calcium chloride in 10 per cent solution and 10 cubic centimeters of calcium lactate in 10 per cent solution separately to two pregnant dogs over a seven day period without any apparent ill effect. During the course of these injections both dogs delivered several living puppies.

The intravenous injections of calcium chloride in patients have been supplemented by doses of calcium by mouth, although Cushny states that "the small quantity of calcium absorbed from the alimentary canal has no obvious effects." This statement does not always hold good since some reduction in an elevated coagulation time can be brought about by the administration of calcium lactate by mouth, although inasmuch as it does not increase the amount of calcium in the blood stream (Grove and Vines), and hence does not combine with the bile pigments circulating in the blood, it does not diminish the patients' toxicity and consequently its value is 50 per cent less than the intravenous administration of calcium. Furthermore, the calcium administered by mouth was found by Lee and Vincent to have little effect in lowering an elevated blood coagulation time until after the third day, while the effect of the intravenous administration of calcium is noticed immediately This is illustrated in Case 353678 (Table IV). The patient showed a reduction in coagulation time to normal after the oral administration of 100 grains of calcium lactate daily for 5 days.

It should be borne in mind that "calcium injected directly into the blood stream acts much like digitalis in that in small doses it accelerates and strengthens the heart, but in large doses it seems to be poisonous, tending to bring the heart to a standstill" (Cushny). In our investigations daily injections of 10 cubic centimeters of 10 per cent calcium lactate and 10 per cent calcium chloride were given for a seven day period without apparent deleterious effect on dogs, and since a maximum of three injections of 5 cubic centimeters of 10 per cent calcium chloride has sufficed to produce a prompt, immediate, and sustained reduction of the coagulation time the intravenous use of the calcium chloride solution in preparing jaundiced patients seems justifiable.

The duration of the reduction in coagulation time for each injection of calcium lactate was found by Lee and Vincent to be 3 days. In our cases we have not definitely determined this point, a study of which will be made later. However, in one case the reduction remained for 14 days, in another 8 days. When the coagulation time tended to lengthen we found that it could be immediately reduced by another intravenous injection of the calcium chloride solution.

Opie, from his experimental work, believes that carbohydrates act in a protective manner to prevent disintegration of the body proteins when the individual is in a state of toxæmia; he found that on giving carbohydrates, fats, and proteins to dogs, before and after chloroform poisoning, the dogs that were fed with fat died first, those fed with protein died second, and those fed with carbohydrate died third or not at all. Mann has been able to keep dogs alive for from 20 to 34 days after the removal of the liver by intravenous, subcutaneous, and intraduodenal injections of glucose. In view of this work, jaundiced patients in the Clinic have been fed large quantities of carbohydrates, and the amount of glucose has been increased by using the Murphy drip proctoclysis of 15 per cent glucose solution in tap water, one hour on and one hour off. Four thousand cubic centimeters of water were given by mouth every 24 hours to increase the body fluids and to aid in the elimination of the bile pigments. Attempts have not been made to carry on these preparations longer than 4 days, because it is believed that this length of time will give the maximum benefit, and that waiting longer might invite another attack of colic, if gallstones are the cause of the biliary obstruction, which would deepen the jaundice and increase the coagulation time. If the patient does not respond to this regimen transfusion of blood is indicated 24 to 48 hours before operation.

In this manner we have prepared for operation 15 patients with obstructive jaundice most of whom would otherwise have been denied operation because of the grave risk due to their elevated coagulation time, dehydration and toxæmia. All of these patients recovered from the operation and were able to return home.

The facts brought out in the study of these cases are illustrated by Case 339670.

Mrs. M., aged 56 years, gave a history of increasing jaundice over a period of 24 months with marked loss of weight and strength. She had had severe abdominal colic often. The large liver and the fluctuating abdomen led several physicians to believe that the bile-ducts and liver were malignant. When her coagulation time was reported to be 14 minutes, it was thought that the operative risk was too great, particularly since the symptoms were 75 per cent in favor of malignancy. The conditions were explained to her, but she refused to leave the Clinic without an operation. She was, therefore, prepared for operation in the manner described and her coagulation time reduced from 14 minutes to 2 minutes in 4 days. At operation stones in the common duct and secondary biliary cirrhosis were found. There was no evidence of malignancy. The patient recovered, and was dismissed from the Clinic 28 days later.

CONCLUSIONS

1. Most patients with obstructive jaundice who die after operation succumb from intra-abdominal hæmorrhage.

2. In most cases postoperative hæmorrhage occurs when the coagulation time of the venous blood is longer than 9 minutes.

3. The coagulation time of the blood can be reduced greatly and the toxicity diminished in patients with obstructive jaundice by daily intravenous injections of 5 cubic centimeters of a 10 per cent calcium chloride solution for a three day period.

4. Carbohydrates and glucose prevent disintegration of body proteins when the patient is in a state of toxæmia.

5. Large quantities of water aid in eliminating toxic bile pigments and increase the body fluids.

6. It is self evident that in operations for obstructive jaundice the various steps of the operation be carried out with the utmost gentleness, care being taken not to traumatize the tissues, especially of the liver, and for this reason cholecystectomy should not be performed at the primary operation if it can be avoided.

I wish to express my thanks to Dr. L. P. Bell for many valuable suggestions received from him and from his thesis "Degeneration and Regeneration of the Liver during Experimentally Produced Obstructive Jaundice" (unpublished).

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BLOOD VESSEL SUTURE[1]

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DURING the past few years a great deal has been written on the subject of vascular suture. It is my purpose in this paper to present a short résumé of the subject and to discuss briefly: (I) the structure of arteries and veins; (II) the indications for suture of the blood vessels; (III) the contra-indications; (IV) the basic principles underlying the different methods of vascular suture and the various suturing operations that may be done; (V) the more commonly accepted methods, in an attempt to make clear and to emphasize the fact that the one method which gives the very best possible results is so extremely simple that any surgeon who possesses even average dexterity can use it, without any special instruments and with only the materials that can be obtained at any dry goods store; (VI) the process of healing of an artery or vein after suture; and (VII) my own experimental experience stating my own views on the subject and bringing in only as many references from the literature as are necessary to emphasize and make clear the above points. I shall not go into the historical aspect of the subject because it has nothing to do with the practical work. Those interested in it will find the excellent articles by Imbert and Fiolle (1), and J. B. Murphy (2) well worth reading. Neither shall I touch upon the surgery of aneurisms which has been so fully covered by Matas (3) and others. I wish merely to discuss the suture of arteries and veins, as it may be met with in ordinary surgical practice, for this is intended to be a very practical paper.

I. STRUCTURE OF ARTERIES AND VEINS (4)

In the case of medium sized and large vessels the structure is about the same, with certain modifications. The medium sized or large artery, which is the one we are called upon to suture most frequently is composed of the following coats: the inner coat or tunica intima, the middle coat or tunica media, and the outer coat or tunica adventitia. The inner coat consists of a layer of endothelial cells, a subendothelial layer of connective tissue, and a layer of elastic tissue, the fibers of which have principally a longitudinal direction. The middle coat consists of plain muscle fibers, arranged circularly around the vessel, and elastic fibers, the laminæ of which alternate with layers of muscular fiber. The tunica media is the coat that gives thickness to the artery. The external coat consists of bundles of white connective tissue with some elastic fibers. This coat is easily separated from the tunica media when the vessel is exposed, as will be seen later.

The structures of an artery and a vein of medium size differ principally as follows: (1) The elastic layer of the internal coat in a vein is not so highly developed. (2) The middle coat is composed of a thick layer of white connective tissue with elastic fibers, the latter in smaller proportion than in the arteries. In some veins there is a transverse layer of plain muscle fibers. The muscular element in veins, however, is much less prominent than in arteries, and the middle coat is, therefore, much weaker. (3) The outer coat is made up of areolar tissue with longitudinal elastic fibers. In the largest veins the outer coat is very thick and contains a large number of longitudinal muscular fibers. (4) Most veins are provided with valves, which prevent regurgitation of blood in them.

Both arteries and veins contain blood vessels for their nourishment. These are found in the outer coat. There are also nerves which have their origin in the sympathetic system and control the muscle fibers of the middle coat.

II. INDICATIONS

Let me say at the outset that the indications for vascular suture are rare, and that the indications combined with conditions, essential for a good result, are extremely rare. However, the surgeon should be acquainted with the technique of the simplest and best

[1] Read before the Ohio Valley Medical Association, Evansville, Indiana, November 16, 1921.

methods so that, should occasion arise, he may be able to suture an important artery or vein as readily as he would the stomach or intestine. Leaving the ordinary aneurisms out of consideration, the indications for suture are the following:

1. Injury to the vessel, with break in its continuity, from any cause, either from without, as in gunshot or stab wounds, or from within (subcutaneous), as in fractures or dislocations or traction on the vessels, as in attempting to reduce a dislocation, or straighten a limb that has been in the flexed position for a prolonged period of time.

2. Where a vessel has been resected in a surgical operation, as may be the case in the removal of certain growths involving the artery or vein, or both, or where a vessel has been accidentally injured during the course of a surgical operation, as in the removal of enlarged glands or new-growths from the neck, axilla, or groin. The femoral artery and vein have frequently been injured during hernia operations, either by passing the needle through one of them or through the deep epigastric artery at its origin. This may require lateral suture.

3. Arteriovenous anastomosis for embolism and thrombosis of the lower extremity, Raynaud's disease, senile gangrene, etc. This is no longer considered an indication by the majority of surgeons, however, as it is usually a failure. These are the main indications for vessel suture, though of course there are many others—notably sacculated and arteriovenous aneurisms, where end-to-end or lateral suture may be necessary.

In the foregoing remarks I have referred particularly to arterial suture. This is because the arteries are far more important than the veins—from the standpoint of vessel suture—as the latter, except the larger ones, may be ligated with impunity, the anastomoses being very free and the superficial veins taking on the function of the deeper ones, when the latter are ligated. This is also the reason why arteriovenous anastomosis is never successful in embolism and thrombosis of the larger vessels of the extremities, or in Raynaud's disease or senile gangrene. The arterial blood turned into a large vein follows the line of least resistance and returns to the heart through the numerous superficial anastomoses—never reaching the capillaries at all. Of course, in the early part of this reversed circulation, the valves in the veins tend to stop the onward flow of blood in them, but they soon break down, as the veins dilate.

As regards the size and importance of vessels: It is hardly worth while suturing the internal jugular vein. Simply tie it off above and below the site of injury, or the tumor which involves it; but it is *always worth while* to suture the common or internal carotid artery, as ligation of either of these is dangerous, due to the fact that cerebral complications so frequently follow. The mortality usually given for ligation of the common carotid artery is 25 per cent, though some operators think this is much too high.

The same remarks apply to the brachial, axillary, subclavian, femoral and popliteal vessels. The *veins*, where suture is absolutely indicated, are the ascending vena cava, especially if the injury is above the entrance of the renal veins. All cases of ligation above its junction with these veins have ended fatally. The sinuses of the dura mater, also, should always be sutured if injured.

I have used the adjective "important" in connection with the arteries. This is because suture is nearly always indicated only in the case of the larger and "important" arteries. The smaller ones may usually be ligated without risk. For instance the ulnar may be ligated and the radial will take care of the circulation of the hand and vice versa. One must always be certain, however, that the other vessel is intact and patent, otherwise suture must be performed. The external carotid is an unimportant artery. The subclavian is an important one, but difficult of suture in all its portions, unless the clavicle is divided and retracted downward. The axillary and brachial arteries are important but decreasingly so as we pass downward. They should always be sutured when possible. Circular or lateral suture of the abdominal aorta is imperative when it has been injured, as all cases of ligation have been fatal. Ligation of the common and external iliac

arteries is dangerous, and also of the femoral and popliteal, because of the liability to gangrene of some portion of the leg or foot. In all these cases suture should be performed if possible. The anterior and posterior tibial and peroneal arteries may, any one of them, be tied without danger.

The conditions which make for success in vascular suture are the following:

1. *Absolute asepsis.* All surgeons and experimenters agree that infection of the field will invariably result in failure, either from intravascular thrombosis or secondary hæmorrhage, so this one absolute rule can be laid down; if the wound is infected or there is infection in the immediate neighborhood of the injured vessel, do not attempt to suture, but always ligate using the Ballance and Edmunds knot on the larger arteries. The reason that vascular suture can be so seldom used, is because the wounds are usually infected when they come under the care of the surgeon. This was the reason that, during the Great War, so few injured vessels were successfully sutured. In the experimental laboratory, where asepsis can be carried out in all its details, the larger vessels can be sutured with almost 100 per cent certainty of success, but in practical surgery this is not so. If the vessel is injured during the course of an aseptic operation, there is no reason why the same good results cannot be obtained as in the laboratory, and this also applies to operations on aneurisms, or the resection of large vessels during the removal of tumors and glands in an aseptic field. In gunshot and stab wounds, however, infection is very likely to be carried in, especially in the case of shrapnel wounds, and in compound fractures where the vessels are injured.

2. *Absence of tension between the united segments of artery or vein.* If much of the vessel is destroyed or a considerable portion has to be cut away in order to secure clean cut ends for union, the tension may be so great that suture is inadvisable. This, of course, must be left to the judgment of the surgeon but I would say that if the tension is great enough to make the anastomosis difficult—ligate instead of suture.

3. *Avoidance of injury to the intima.* This is rather important and no more injury to the intima, than is absolutely necessary, should be inflicted. With this end in view, one should never use an ordinary artery forceps to secure the temporary hæmostasis necessary in vascular suture. The best instrument for this purpose is the Crile screw clamp, with or without rubber tubes over the blades, but if these are not at hand, as might easily happen in an emergency case, any ordinary hæmostat may be made to serve, as is shown in Figure 1. Here small rubber tubes are drawn over the blades of the hæmostat and a narrow elastic band is wound around the shafts, above the clasp and below the finger rings. The tension is regulated by the number of turns of this rubber band. By means of this appliance, injury of the intima is impossible. Of course, in every anastomosis of an artery or vein, there must of necessity be some injury to the intima at the line of union, because even by the most perfect eversion methods, the endothelial surfaces cannot be so perfectly and evenly approximated, that the sutures, pins or clamps, or the injured endothelium, through which they pass, will not at some point be in contact with the blood stream. If, however, these slight injuries be aseptic, the microscopic coagula, which form at their sites, will be quickly covered by endothelial cells from each end, and no occlusion or even narrowing of the vessel, will result. Even in the case of the through-and-through stitch, where the suture material is exposed to the blood stream, if perfect asepsis exists, the suture material will be quickly covered with endothelium and not the slightest harm ensue. However, so long as injury to the intima is a source of danger and can be avoided to some extent, every precaution should be taken to prevent it.

The very finest toothed tissue forceps should be used in handling the ends of the vessels while suturing and the very finest needles and suture material obtainable should be employed. The latter can always be obtained, and if one has not the fine toothed forceps, the larger ones without teeth may be used.

So much for injury of the intima.

4. Keeping the exposed ends of the vessels moist with warm normal salt solution throughout the operation and preventing them from coming in contact with the surrounding tissues, all of which contain coagulating substances. This is easily done by placing a piece of aseptic gauze, soaked in normal salt solution, under the vessel ends and frequently flushing out the ends with the same solution by squeezing it from another sponge. Drying of the vessel ends favors coagulation, as does contact with other tissues.

5. Preventing the adventitia from coming between the injured ends of the vessel. When an artery is severed, the ends immediately retract from each other and the loose adventitia tends to plug them, thus partly stopping the hæmorrhage. As will be seen later, the first step in every anastomosis is to pull the adventitia over the severed ends as far as possible and cut it off. It used to be thought that any interference with the outer coat was likely to cause disturbances of nutrition of the vessel wall, but now we know that this is not true, at least to the extent of cutting off the redundant portion.

III. CONTRA-INDICATIONS

I think that the contra-indications have been quite fully brought out in a negative manner in the foregoing. (1) Sepsis is the principle contra-indication, (2) any considerable degree of tension between the ends of the vessel, (3) when the general condition of the patient is such that he is unable to stand the rather prolonged operation of vessel suture, (4) when the vessel is so severely injured that it cannot be repaired, (5) when the injured vessel is so inaccessible that suture is impossible, and (6) where there is a marked degree of arteriosclerosis.

The results of vascular suture are most favorable when the ideal conditions mentioned are present. These ideal conditions, however, are rarely combined in one case; therefore, we seldom see a perfect result. They have been reported in the literature, however, by unprejudiced observers, and with these precedents in mind, we should always employ the procedure when indicated and possible.

IV. THE BASIC PRINCIPLES UNDERLYING THE DIFFERENT OPERATIONS OF VASCULAR SUTURE

Under this head I shall mention first the simplest method, namely: direct end-to-end, side-to-side or end-to-side anastomosis, the suture material penetrating all of the coats or all except the intima. This is best exemplified in the methods of Carrel and Glueck. Second, the eversion methods, either by means of sutures only (Dorrance, Salomoni and Tomaselli, Smith and Bickham), or by means of absorbable magnesium rings (Lespinasse); third, the invagination method of Murphy, where the proximal end is drawn into or invaginated into the distal end; fourth, the combination of eversion and invagination methods, as the method of Payr. One of these four basic principles underlies every arterial anastomosis, except, of course, where a paraffined tube of metal or glass is used temporarily to carry on the circulation. As the latter must of necessity be temporary, I shall not consider it.

The different suturing operations which may be done on the blood vessels are the following: (1) End-to-end union of artery or vein. (2) End-to-side union of artery or vein. (3) Side-to-side union of artery or vein. (4) Lateral suture of artery or vein for injury, or in the treatment of arteriovenous aneurisms, after extirpation of the sac. The method of Matas is also a lateral suture method, though in this, the everting sutures are introduced within the sac, thereby obliterating it. (5) Arteriovenous anastomosis,—usually end-to-end, though it may be end-to-side (end of vein in the side of artery). (6) Transplantation of a segment of vein into an arterial defect. This may be done by taking the segment from the patient at the time of operation and making two end-to-end sutures, in cases where too much of the artery has been destroyed to do a direct end-to-end anastomosis; or "cold storage" transplantation may be done, either with segments of human veins, kept in normal salt solution at a temperature of 32 to 34° F., or segments of veins from one of the lower animals, as the sheep or dog, kept in cold storage until used. Most of these latter operations have been

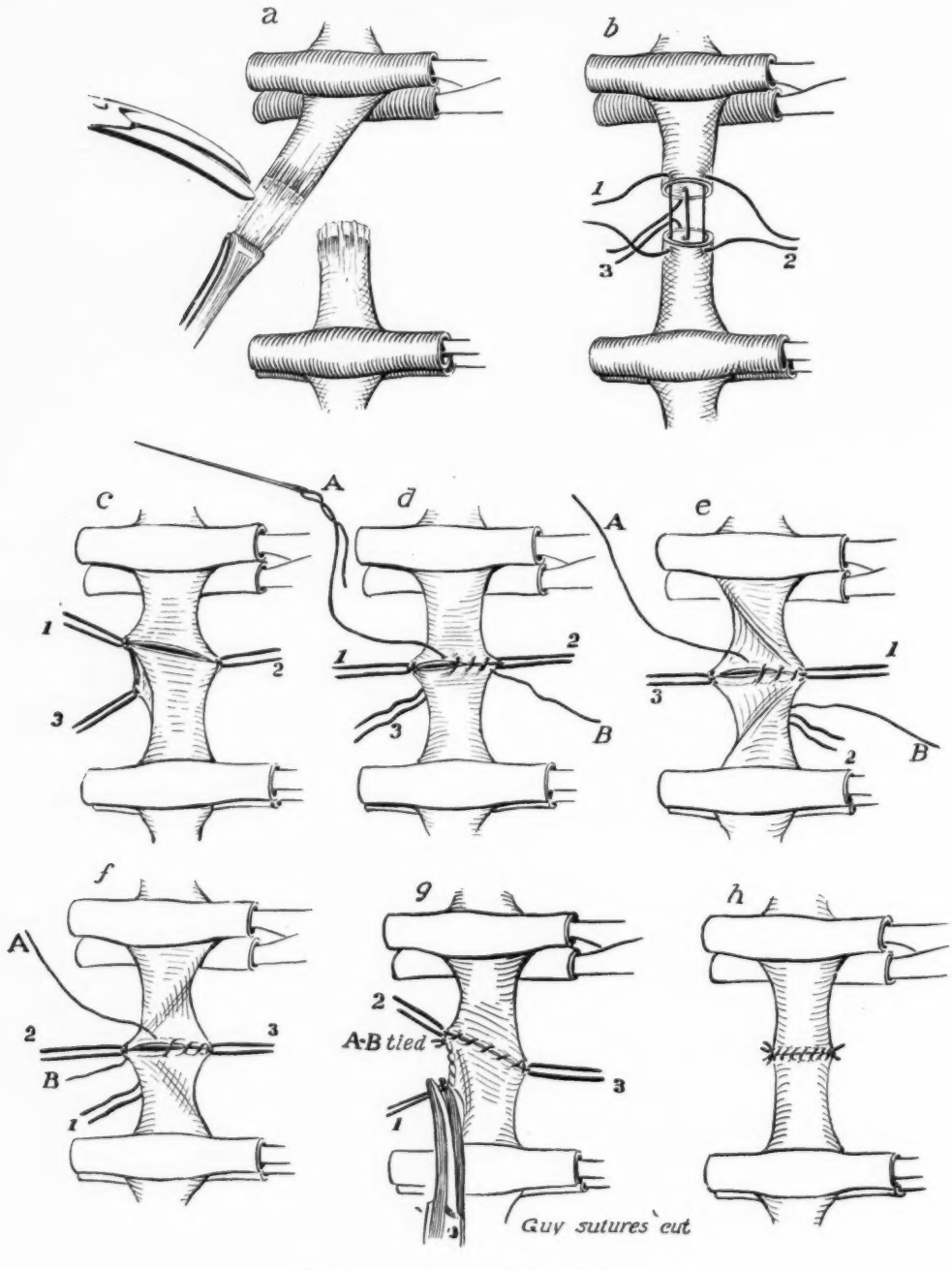
done in the laboratory, though a very few have been performed on man, without success so far as I know. (7) Patching an arterial defect with a piece of fascia, peritoneum, or the wall of a vein. This, too, is a laboratory operation. The patch is simply sewed into the defect, the sutures passing through all of the coats, or all except the intima.

V. TECHNIQUE OF DIFFERENT METHODS

I shall first describe the technique of the method, which I consider the best of all, that of Carrel, as it is so simple that any surgeon can carry it out with materials that may be procured at any dry goods store. The instruments and materials necessary are the following: Three or four very fine straight sewing needles (Fig. 2), Nos. 12 or 14 preferred, with as long an eye as possible to facilitate threading, the same number of lengths of fine silk thread, Nos. 0, 00 or 000 preferred, each 16 to 20 inches long (the needles are threaded with the silk before sterilizing); two Crile screw clamps, or ordinary hæmostats arranged as described above with the rubber tubes over the blades and narrow rubber bands wound around the shafts near the finger rings to keep the blades in apposition, two fine toothed tissue forceps for handling the ends of the arterial segments; sharp straight manicure scissors; sterile vaseline, with which to coat the needles and thread; sterile warm normal salt solution with gauze sponges, etc.; scalpel, artery forceps, and scissors.

These materials are necessary in nearly all methods, so I shall not repeat, in my description of other techniques.

After preparing the field carefully as for any other aseptic operation, the artery to be sutured is cut down upon and exposed. Any clots are turned out and if the vessel is actively bleeding, digital pressure should be used to control it. It is well to expose the vessel for at least 1¼ inches above and below the site of injury, so that it may be handled without too much traumatism. Next, place a Crile screw clamp on each segment of the vessel, about 1 inch from the severed end and, by means of the screw, compress the vessel just enough to stop the flow of blood. The field should now be cleansed with sterile normal salt solution, and a dressing soaked with it placed under the vessel to prevent contact with the surrounding tissues. Wash out the ends of the segments with the same solution and keep them moist throughout the operation. If the ends of the segments are ragged and uneven, cut them squarely across so that the ends to be united will be sharp and regular. Now with a fine toothed forceps draw the adventitia over the ends of the vessel and cut it off with a sharp manicure scissors (Fig. 3). The threaded needles and silk should be dipped in sterile melted vaseline or paraffin oil, if they have not already been sterilized in them. This answers a three-fold purpose: it prevents coagulation of blood on the sutures which are exposed in the blood stream, the sutures slip through the vessel walls more easily, and the vaseline tends to plug the perforations produced by the needles, by accumulating around the silk. A silk suture is passed through the entire thickness of the vessel wall of one segment from without inward, as near the end as possible, and then through the opposing end in the same manner but from within outward, penetrating the two ends in exactly corresponding positions, as the vessel lies in the field. The two ends of the silk are now grasped in a hæmostat and this constitutes guy rope number 1. Guy rope number 2 is passed in exactly the same manner at a distance, one third around the circumference of the vessel from number 1. Guy rope number 3 is passed in the same way —one third of the circumference from number 2. Thus we have three guy ropes uniting the two ends of the vessel, equidistant from each other and all held by hæmostats (Figs. 3–10, *b*). The assistant now brings the ends of the vessel together and the three guy ropes are tied (Figs. 3–10, *c*), the long ends being still held with hæmostats. Now the assistant makes traction on guy ropes 1 and 2, allowing guy rope 3 to *drop*. This converts the circular circumference of the artery into a triangle, as shown in *c*, Figs. 3–10. With the arterial ends held in this manner, a continuous suture of the same fine silk on another very fine needle is started at guy rope number 2, where it is tied, and continued through all coats of the vessel, as an over and over stitch, uniting the



Figs. 3 to 10. (Legends on opposite page.)

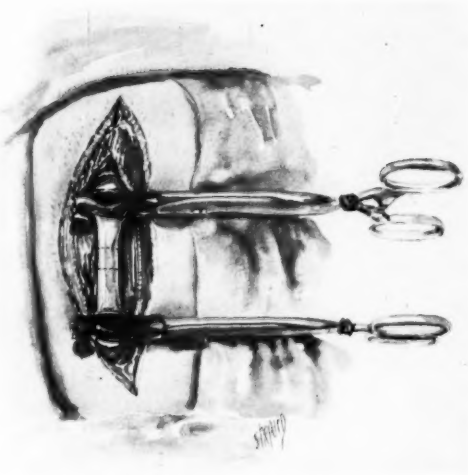


Fig. 1. An ordinary hæmostat which may be made to take the place of the Crile clamp.

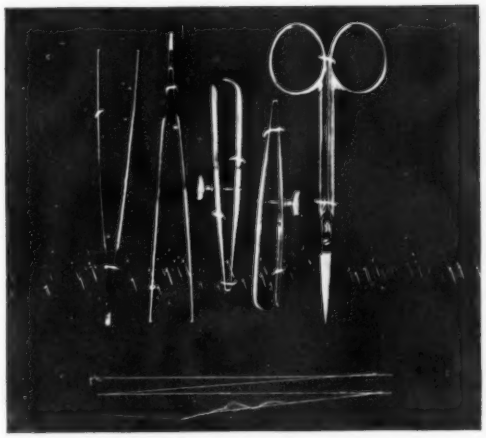


Fig. 2. The instruments used in suture of the vessels.

edges accurately as shown in *d*, Figures 3 to 10. The sutures are introduced as closely to the edges as possible and as *near* together as is necessary to secure perfect approximation. When guy rope number 1 is reached the suture is continued around it and traction is made on guy ropes numbers 3 and 1, 2 being dropped. This twists the vessel through a third of its circumference and brings the edges of the vessel between 3 and 1 into the field, as shown in *e*, Figures 3 to 10. These edges are united in exactly the same manner by the same continuous suture, passing through all of the coats, until guy rope 3 is reached. The suture is passed around 3 and traction is made on guy ropes numbers 2 and 3, dropping number 1, as shown in *f*, Figures 3 to 10. This brings the last side of the triangle into the field and the same suturing process is continued between 2 and 3, the end of the continuous suture being tied to its beginning, or to guy rope 2, where it began. The circular suture is now complete and all that remains to do is to cut the guy ropes and suture ends close to the vessel, as shown in *g*, Figures 3 to 10, when we will have a perfect circular end-to-end anastomosis, as shown in *h*, Figures 3 to 10. The distal Crile clamp is now removed and then the proximal one. When the circulation is re-established, there will be bleeding through some of the stitch holes, especially where the guy ropes were inserted, but this invariably stops after a few minutes' light compression with a gauze sponge soaked in warm normal salt solution. It is not necessary to suture the sheath of the vessel over the line of suture, but simply allow the muscles to fall back into place, suture the deep fascia at a few points and carefully close the wound in the skin. I have described Carrel's method in detail because I am convinced from my experimental work that it is

Fig. 3 (*a*). The clamps are in place on the vessel and the adventitia is being drawn over the end of the vessel, about to be cut off by the scissors.

Fig. 4 (*b*). The three guy rope sutures, equidistant from each other are in place, having been passed through all coats of the vessel. Guy ropes 1, 2 and 3.

Fig. 5 (*c*). Guy ropes 1, 2, and 3 are tied, traction is being made on them and the circular circumference of the artery is converted into a triangle.

Fig. 6 (*d*). The continuous silk suture has been started at 2 and is uniting the edges, passing through all of the coats.

Fig. 7 (*e*). Traction is now being made on guy ropes 1 and 3, twisting the vessel through one-third of its circumference. The same continuous suture, *b*, is shown passing through all coats of the vessel.

Fig. 8 (*f*). The continuous suture, *b*, has passed guy rope 3, traction is being made on 2 and 3, after having passed 3 beneath the vessel. Traction on 2 and 3 now twists the vessel through another one-third of its circumference, but in the opposite direction.

Fig. 9 (*g*). The continuous suture around the vessel is now complete and the guy ropes are being cut.

Fig. 10 (*h*). The guy ropes and continuous sutures have been cut and the end-to-end anastomosis is complete.

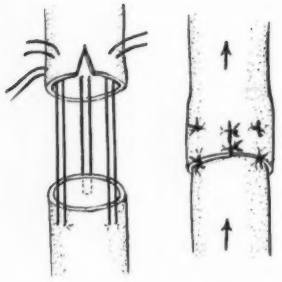


Fig. 11.

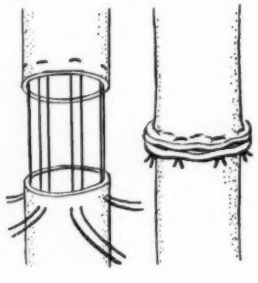


Fig. 12.

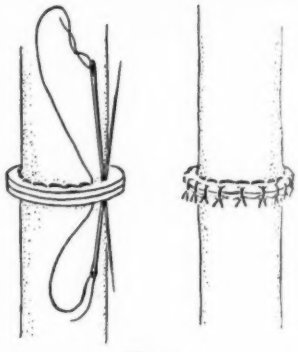


Fig. 13.

Fig. 11. The invagination method of Murphy. Shows the distal end split a short distance, and the three invaginating guy ropes in position, ready to draw the proximal into the distal end. The second picture shows the operation complete, with the guy ropes tied and cut, the slit sutured, and the fixation sutures in position.

Fig. 12. Shows the eversion method which may be accomplished by either the interrupted or continuous suture. Another continuous over-and-over stitch may be used to unite the free edges, and thus produce a more perfect union.

Fig. 13. Showing the cobbler's stitch. This produces an eversion of the edges, which are united by a second row of interrupted sutures.

the best and gives the highest percentage of successful results. I have used it many times on the common carotid and femoral in dogs and once in the horse, with 80 per cent perfect results. It is the one method among all others that any surgeon can use with materials that are always at hand. If a small vessel must be sutured, the ends should be cut obliquely, to make the approximating surfaces as large in surface extent, as possible.

The invagination method of Murphy is shown in Figure 11. The same preliminaries are carried out as described for Carrel's method. The distal segment is split a short distance so that it may receive the proximal end which is drawn into it by three mattress sutures, placed equidistant, as near the end as possible and penetrating only the outer and middle coats. These sutures carry a fine

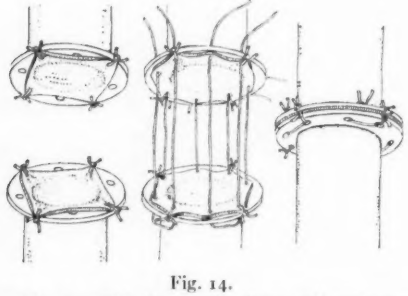


Fig. 14.

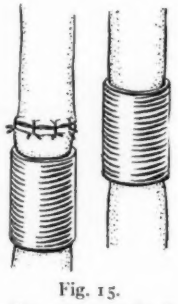


Fig. 15.

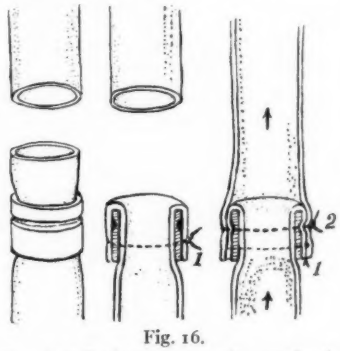


Fig. 16.

Fig. 14. This drawing is almost self-explanatory. The magnesium rings are held in position on the two vessel ends by 4 guy ropes, which produce an eversion of the ends. The second picture shows the mattress sutures in place, while the third shows the vessel ends brought together, the mattress sutures tied, and cut. The introduction and position of the sutures is well shown. The method of Lespinasse.

Fig. 15. The method of Glueck. The ends are united by interrupted sutures, which penetrate all the coats, except the intima. A cuff of artery or vein, previously drawn over one segment, is now made to cover the line of suture.

Fig. 16. The method of Payr. A cylinder of metallic magnesium has been slipped over the proximal segment, with the groove toward the vessel end. In the second picture the end has been everted over the cylinder and tied onto it back of the groove. In the third picture, the distal segment has been drawn over the proximal and secured by another suture tied in the groove.

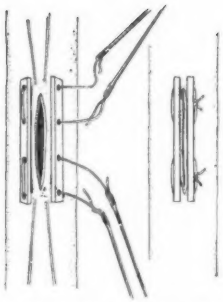


Fig. 17. The method of application of the plates of Lespinasse. Guy ropes are inserted at each end of the wound to put it on the stretch, a plate is placed on each side and secured by mattress sutures as shown.

needle at each end, and after being inserted into the proximal segment, penetrate the distal, from within outward in corresponding positions. After all of them are inserted, traction is made and the invagination thus produced. They are then tied, the slit is closed, and the distal segment secured to the proximal by a few interrupted sutures as shown in Figure 11.

The main objections to the invagination method are the following: too much of the artery is used in making the anastomosis; the lumen is narrowed to a considerable degree, as would be the inside diameter of any flexible tube if it were cut across and one end drawn into the other; the cut end of the proximal portion is exposed in the distal segment, and is in contact with the blood stream. This, of course, favors coagulation. In the few cases in which I tried it on the dog, intravascular thrombosis always resulted.

The principal eversion methods are those of Salomoni and Tomaselli, Dorrance, Smith, Bickham, and Lespinasse. The first five employ suture materials only; the last, rings of metallic magnesium. In the method of Dorrance a fine needle, carrying fine silk is passed as near the edge as possible in one cut end, from without inward, through all coats, and through the other in a similar manner, but from within out. It is then carried on as a continuous stitch, passing from without inward, on the last segment and from within out on the first, until the entire circumference is approximated. This is reinforced by a con-

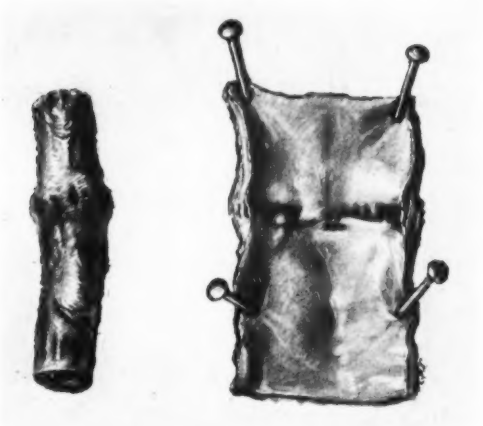


Fig. 18. The common carotid artery nearly 4 weeks after it had been resected and sutured by Carrel's method. There is thickening at the line of suture but no contraction nor dilatation. In the open specimen the sutures are covered by endothelium.

tinuous over-and-over suture uniting the edges. Instead of a continuous mattress suture, interrupted ones may be used, accomplishing the same result. (See Fig. 12.) As will be seen from the illustration an eversion of both ends is thus produced. Smith used a fine thread sewing machine needle, on a handle, introducing the needle from without inward on one end and from within out at the corresponding position of the other end. He then passed a piece of catgut or kangaroo tendon through the loop on the farther side and, after withdrawing the needle, tied the silk over another piece of catgut on the near side. This sewing machine stitch is continued around the entire circumference of the vessel, using the same pieces of catgut or kangaroo tendon to splint it on each side. The method of Bickham is an eversion of the cut edges of the vessel, by means of a cobbler's stitch, using two fine needles on the same thread, as shown in Figure 13. Later, interrupted sutures unite the everted edges.

Lespinasse describes five different methods for use with his perforated rings of metallic magnesium. I shall describe only one, which seems to embody all of the features of the others and is the simplest. The rings are of pure metallic magnesium, flat, 1 millimeter

Fig. 19. Photomicrograph of a sutured common carotid artery, 4 weeks after operation. The endothelial cells have bridged across at the line of union (the depression) but there is no regeneration of the muscular or elastic tissues. The union has taken place entirely by fibrous tissue formation. Fragments of silk may be seen in the open space to the left. The dark area below the depression is round cell infiltration in the adventitia. (45 diameters.)

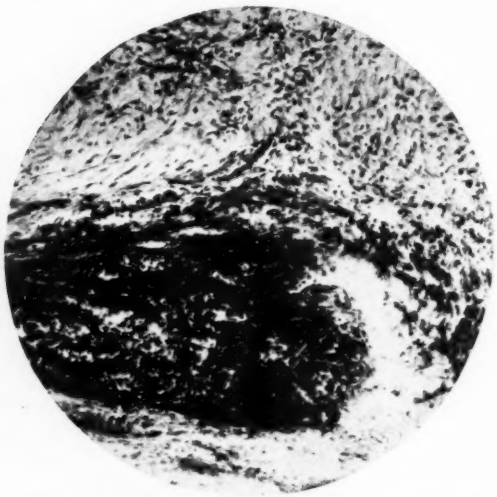


Fig. 20. High power photomicrograph of the same specimen. It shows that the union has taken place entirely by fibrous tissue formation, and that there is no regeneration of the muscular or elastic tissue. The dark area is round cell infiltration in the adventitia. (110 diameters.)

thick and from 1 to 2 millimeters in width. The rings vary in size according to the size of the arteries on which they are to be used. Each ring has 8 perforations. The technique here described is method III. A ring of appropriate size is slipped over each end of the vessel and secured to the latter by four equidistantly placed silk sutures, passing through every second perforation and through the entire thickness of the vessel wall, as near the edge as possible. These may be used as guy ropes. These sutures, when tied, with the knots at the edges of the rings, will evert the vessel ends and produce the condition shown in Figure 14. The next step is to pass a mattress suture, first through the ring and vessel edge on one side, with the guy rope, then through the corresponding perforation in the opposite ring, carrying the corresponding guy rope; then backward through the next perforation in the ring between the guy ropes, picking up the edge of the vessel, over to the other side, through the opposite edge of the vessel, and lastly through the corresponding perforation in the other ring. Four of these mattress sutures are passed in the same way and when tied, bring the everted ends of the two segments in accurate approximation, endothelial surface to endothelial surface. Finally the mattress sutures are cut short and the operation is complete. The metallic magnesium is ultimately absorbed. The technique is rather difficult to describe, but is readily understood from the illustrations (Fig. 14).

The disadvantages of all these eversion methods is that the lumen is necessarily narrowed at the line of union, and the operation rather difficult and prolonged. It is well to remember that we are not dealing with large tubes but rather with small ones, which require very careful handling and all manipulations are, therefore, of necessity very fine and delicate.

The method of Glueck, as shown in Figure 15, is no longer used. He united the segments end-to-end, with interrupted sutures, not penetrating the endothelial coat, and reinforced the line of suture with an isolated segment of artery or vein, or a cylinder of decalcified bone, ivory or rubber, which had

been previously slipped over one end and, after the sewing was completed, pulled over the line of suture. As I have said before, the method is obsolete.

Payr used thin cylinders of metallic magnesium, in which a groove was sunk toward one end. They were of various sizes to correspond with different sized arteries. The technique was to slip an appropriate sized cylinder over the proximal end of the severed vessel, with the grooved end toward the edge (Fig. 16). The end of the artery was then everted over the cylinder and a fine silk ligature was tied around it, either over the groove or back of it. Now the distal segment was drawn over the proximal everted segment and another ligature tied around it over the position of the groove (Fig. 16). As will be seen, this operation is a combination of eversion and invagination and has the disadvantages of using too much vessel, of narrowing the lumen at the site of anastomosis, and of having a foreign body around the vessel. Magnesium absorbs slowly with the evolution of hydrogen. To be sure, the gas is usually not a disadvantage, but it is certainly not an advantage.

So much for end-to-end anastomosis. As regards the repair of lateral wounds of the vessels, the technique is exactly the same only applied differently. One may use Carrel's method, the suture passing through all of the coats, beginning about $\frac{1}{16}$ inch from one end and terminating the same distance beyond the other end. Smith's sewing machine stitch may also be used, splinting the interrupted or continuous sutures on both sides with catgut or kangaroo tendon, thus producing an eversion of the wound edges. Lespinasse has devised perforated plates of metallic magnesium which are used with mattress sutures of fine silk, as shown in Figure 17. Carrel's method is the best, as it produces the least constriction of the lumen.

VI. THE PROCESS OF HEALING OF AN ARTERY OR A VEIN AFTER IT HAS BEEN REPAIRED OR ANASTOMOSED

Figure 18 shows the common carotid artery of a dog 4 weeks after it had been resected and united, end-to-end, by Carrel's method. The section of artery has been removed and split open. As will be seen there is a marked thickening at the line of suture and, on the inside, the sutures of black silk may be seen covered by endothelium. There is no clot formation anywhere and the lumen is not constricted nor dilated. Microscopic examination of this and many other specimens show that the union is accomplished entirely by fibrous tissue formation between the ends of the vessel (Figs. 19 and 20), and that there is no regeneration of the muscularis or the elastic layers. The only tissue that does regenerate is the endothelial lining which quickly bridges over the gap and covers the sutures if they are exposed in the lumen. There is only one thing that prevents this endothelial proliferation and, in turn, causes thrombosis after a properly performed operation, and that is infection.

Infection of the wound may be entirely superficial, and not involve the deeper structures and vessels, as was shown in Experiments 15 and 16. In the majority of cases, however, where infection does take place, it extends deeper than the surface and produces an intravascular thrombosis.

VII. CONCLUSIONS

I have done a considerable amount of experimental work on the larger blood vessels, particularly along the lines of gradual occlusion and vessel suture. Below I give a tabulated list of 19 vessel suture experiments, with conclusions. I have done many other experiments which are not included in the tabulation, because the methods tried were entirely unsatisfactory or because the records were incomplete. For instance, I have tried resection of the arteries, with end-to-end anastomosis by means of the "baseball" stitch, the sutures placed as closely together and as accurately as possible. This method is absolutely impracticable, in my opinion, because the alternating eversion and inversion, produced by this stitch, permits of too much hæmorrhage after the clamps have been removed, and very little real approximation of the edges of the vessel ends. I have also used a number of different suture materials, not noted in the tabulation, for example, silk,

TABLE I. VESSEL SUTURE EXPERIMENTS

No.	Animal	Vessel Sutured	Type of Suture	Method	Time from Operation to Examination	Thrombosis ?	Constriction of Lumen	Course of Healing Remarks
1	Dog 24 lbs.	Rt. common carotid.	End-to-end, 1/8 inch resected.	Carrel looped stitch.	3 weeks.	Yes.	Yes.	Primary union.
2	Dog 35 lbs.	Rt. common carotid.	End-to-end, 1/4 inch resected.	Carrel simple. 3 guy ropes.	26 days.	No.	No.	Primary union.
3	Dog 25 lbs.	Rt. common carotid.	End-to-end, 1/4 inch resected.	Carrel simple. 3 guy ropes.	17 days.	No.	No.	Primary union.
4	Dog 13 lbs.	Rt. common carotid.	End-to-end.	Carrel simple. 3 guy ropes.	10 days.	Yes.	Yes.	Primary union—Clot shows no growth after 36 hours; vessel was very small.
5	Horse 750 lbs.	Rt. common carotid.	End-to-end, 1/4 inch resected.	Carrel simple. 3 guy ropes.	5 weeks.	No.	No.	Primary union.
6	Horse same as 5.	Internal jugular vein.	Longitudinal cut in vein; 1-in.	Simple over and over stitch.	5 weeks.	No.	No.	Primary union.
7	Dog 75 lbs.	Rt. common carotid.	End-to-end.	Murphy's invagination method.	20 days.	Yes.	Yes.	Primary union—Artery at line of union united perfectly.
8	Dog same as 7.	Left common carotid.	End-to-end.	Carrel.	20 days.	No.	No.	Primary union.
9	Dog 42 lbs.	Rt. common carotid united to rt. external jugular.	End-to-end.	Carrel.	18 days.	No.	No.	Primary union. Proximal end of artery to distal end of vein.
10	Dog. same as 9.	External jugular united to rt. common carotid.	End-to-end.	Carrel.	18 days.	No.	No.	Distal end of common carotid united to proximal end of ext. jugular vein.
11	Dog 45 lbs.	Rt. common carotid.	End-to-end, 1/4 inch resected.	Murphy's invagination method.	3 weeks.	Yes.	Yes.	Primary union.
12	Dog same as 11.	Left common carotid.	End-to-side anastomosis.	Carrel.	3 weeks.	No.	No.	Primary union.
13	Dog 100 lbs.	Rt. common carotid.	End-to-end, 1/4 inch resected.	Eversion — 9 interrupted sutures.	6 days.	Yes.	Yes.	Dog died after 6 days; cerebral anæmia. Primary union.
14	Dog same as 13.	Left common carotid.	End-to-end, 1/4 inch resected.	Murphy's invagination method.	6 days.	Yes.	Yes.	As above.
15	Dog 48 lbs.	Rt. common carotid.	End-to-end, 1/4 inch resected.	Eversion—3 guy ropes and continuous everting stitch.	6 weeks.	No.	No.	Superficial infection only.
16	Dog same as 15.	Left common carotid.	End-to-end, 1/4 inch resected.	Eversion as in dog No. 15.	6 weeks.	No.	No.	See above—No. 15.
17	Dog 42 lbs.	Rt. common carotid.	End-to-end, 1/4 inch resected.	Eversion—6 interrupted sutures and running stitch one-half way around to control bleeding.	33 days	No.	No.	Primary union.
18	Dog same as 17.	Left common carotid.	End-to-end, 1/4 inch resected.	Eversion — 3 guy ropes; continuous everting circular stitch.	33 days.	No.	Yes.	Primary union. Constriction but artery not closed.
19	Dog 42 lbs.	Left common carotid.	End-to-end, 1/4 inch resected.	Carrel.	22 days.	No.	No.	Primary union.

linen, human hair, horse hair, very fine bronze wire and catgut. I have found that fine silk answers the purpose better than anything else. It can always be procured, is fine, strong, and is easily handled. I have used curved needles as well as straight ones and am convinced that the straight ones are better because they are always at hand and can be used without a needle holder. The sewing machine needle method or any other based on this principle, has no place in vessel suture, as it complicates an otherwise simple procedure.

I think that I have now set forth and made clear my opinion in regard to the very simple, but supposedly very complicated operation, of the suture of arteries and veins.

The tabulation of experiments and conclusions follow:

SUMMARY

End-to-end anastomosis—17 cases		
Carrel method—9 cases		
Not thrombosed	7 cases	78 per cent
Thrombosed	2 cases	22 per cent
Eversion method—5 cases		
Not thrombosed	4 cases	80 per cent
Thrombosed	1 case	20 per cent
Murphy method—3 cases		
Not thrombosed	3 cases	100 per cent
End-to-side anastomosis—2 cases		
Not thrombosed	2 cases	100 per cent
Arteriovenous anastomosis—2 cases		
Not thrombosed	2 cases	100 per cent
Lateral longitudinal wound in vein —sutured—1 case		
Not thrombosed	1 case	100 per cent

One dog died of cerebral anæmia, as a result of both arteries becoming thrombosed. Experiment 8.

There was superficial infection of wound in Experiment 13. The infection did not extend to the artery.

There was marked narrowing of the vessel in Experiment 18.

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THE DIAGNOSIS AND SURGICAL TREATMENT OF TUMORS IN FRONT OF THE SPINAL CORD[1]

By CHARLES A. ELSBERG, M.D., F.A.C.S., New York

TUMORS that grow on the anterior surface of the spinal cord—whether they are extradural or intradural—give rise to symptoms which are often difficult to differentiate from intramedullary growths. For this reason surgical interference is often delayed until marked cord symptoms have appeared. Furthermore, the exposure and removal of these anterior tumors is often difficult. After the surgeon has performed the laminectomy and has incised the dura, he must draw the exposed part of the cord over to one side in order to expose and extirpate the growth. Even when the manipulations are carried out with gentleness and care, the danger of injury to the delicate cord tissue is very great.

It is important, therefore, that the diagnosis of spinal cord tumors in this location should be made as early as possible, and it is equally important that the surgical procedure for the exposure and removal of the growth shall be one that will reduce to a minimum the dangers to the delicate cord tissue.

About 10 per cent of extramedullary spinal tumors are located anteriorly and anterolaterally to the spinal cord. As the dentate ligament forms the boundary between the anterior and posterior halves of the cord, any tumor that develops in a location anterior to the plane of the dentate ligament must be considered as lying on the anterior aspect of the cord. If, however, the growth lies in front of the dentate ligament—between it and the anterior spinal roots—its location is, more strictly speaking, on the anterolateral aspect of the cord. On the other hand, all growths that lie in front of one or more anterior spinal nerve roots, no matter whether they are mesially or laterally placed, are true anterior growths. Frazier has collected 330 cases of spinal cord tumor, in 35 of which (10.6 per cent) the growth lay on the anterior or anterolateral aspect of the cord. In 9 of

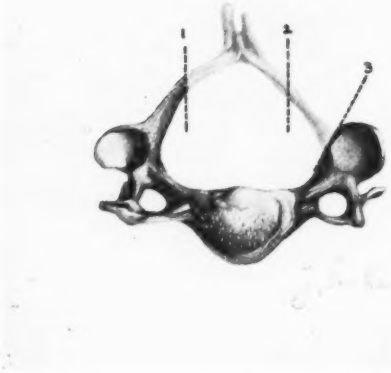

Fig. 1. A cervical vertebra, showing, *1–2*, the amount of bone to be removed for an ordinary laminectomy, and, *1–3*, the amount to be removed for the approach from the right to a tumor in front of the cord.

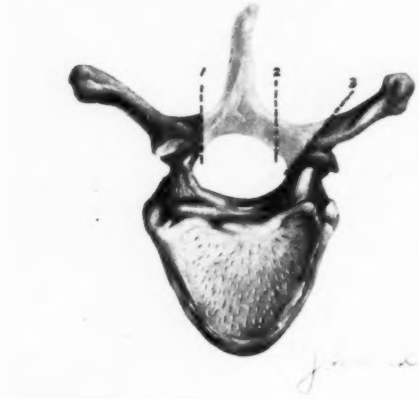

Fig. 2. A dorsal vertebra, *1–2*, the ordinary laminectomy; *1–3*, laminectomy for approach of tumor in front of cord from the right.

[1]Primary and secondary malignant growths of the bodies of the vertebræ are not included.

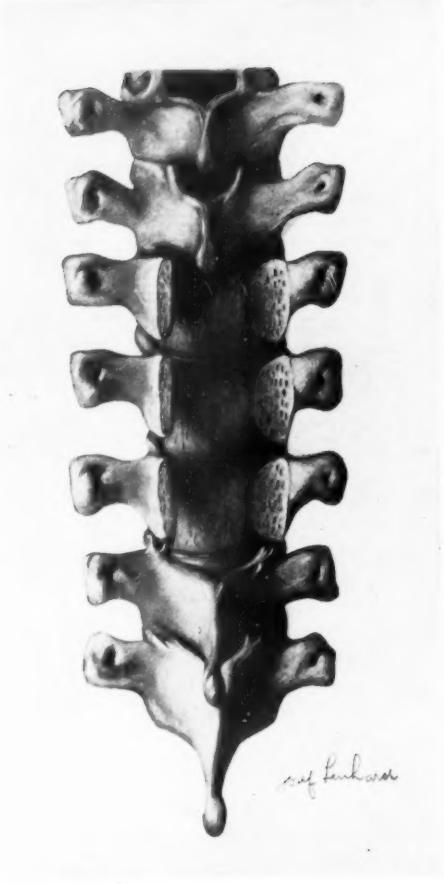

Fig. 3. The amount of bone to be removed in a laminectomy for approach, from the right side, to a tumor in front of the spinal cord.

82 spinal tumors that I have operated on, the tumor developed in front of the cord (10.9 per cent).

These anterior growths usually have a painless beginning. Muscle atrophies are often the first sign of the disease. When the tumor is located in the lower cervical region, the first symptom may be an atrophy of the small muscles of the hand on the one or the other side. If the patient is examined in this stage, there may be few or no sensory disturbances, and when signs of sensory loss do appear, the patient is apt to notice first a disturbance in

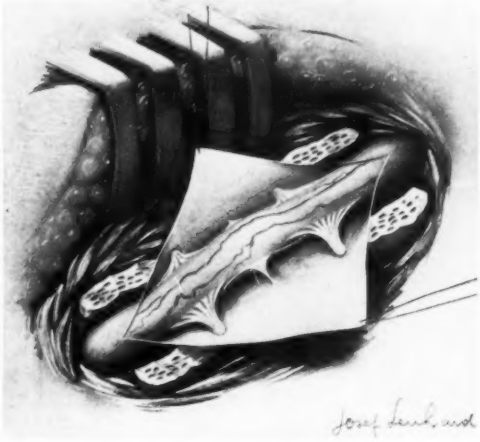

Fig. 4. The spinal cord pushed backward by a tumor in front of the cord.

feeling in the lower limbs. I have seen a number of cases of tumor of the spinal cord located anteriorly, where the patients had for a number of years, an increasing spasticity of the lower limbs without sensory loss in any part of the body. We have learned to suspect an anterior spinal cord tumor in any patient who has an increasing spastic paraplegia without or with only indefinite sensory disturbances.

The sensations of pain and temperature may be disturbed first and the whole clinical picture—muscle atrophies with dissociated sensory disturbances—may be that of an intramedullary disease. Sooner or later, however, all types of superficial and deep sensibility become affected.

In syringomyelia and in intramedullary growths sensory disturbances usually appear first, and precede the muscle atrophies. In the early stages of intramedullary disease, it is often difficult to determine the upper level of the lesion. As Head has repeatedly emphasized the upper areas of disturbed sensibility often shade very gradually into those of normal sensation. Besides, an upward shifting of the level signs is not rare in intramedullary disease; in anterior spinal new-growths, however, the level signs remain constant. As I have already stated, in these anterior growths level signs may be wanting

Fig. 5. Partial exposure of tumor in front of the cord by traction on a slip of the dentate ligament.

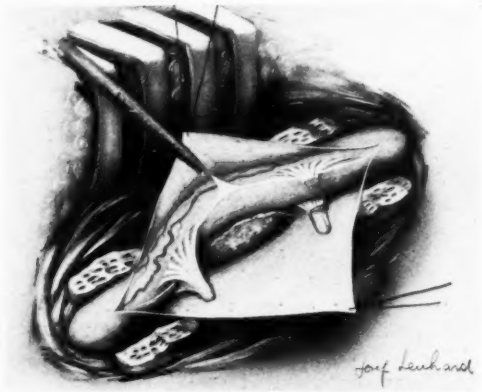

Fig. 6. Complete exposure of a tumor in front of the cord by traction on a slip of dentate ligament after division of one posterior root.

for a long period of time, but when sensory level signs begin to appear, they increase with considerable rapidity. A patient who had previously had only indefinite signs of a local spinal lesion may within a few weeks or months develop perfectly characteristic signs of a local spinal cord compression.

REMOVAL OF GROWTHS IN FRONT OF SPINAL CORD

The operative procedures may be either intradural, extradural, or transdural, depend-

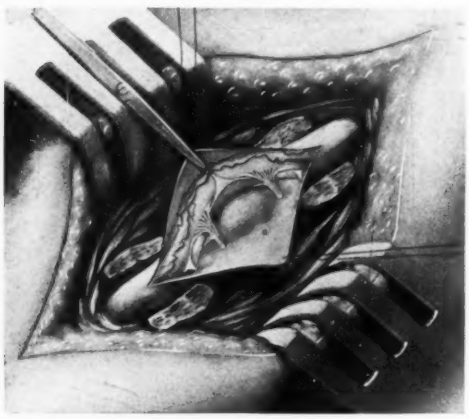

Fig. 7. Removal of extradural tumor by the transdural route. Exposure of tumor in front of the spinal cord.

ent upon the location and the size of the growth. The exact location of the growth can, in many instances, be determined only after the dural sac has been opened.

For the removal of these anterior tumors the removal of the laminæ of the vertebræ must be extensive.

After the tumor has been located, the laminæ must be rongeured away on one side down to the transverse processes. In the cervical region the wide removal of the laminæ on one side (Fig. 1) will be sufficient to allow of a direct anterior approach to the growth. In the dorsal regions the base of the transverse processes on one side must often be removed (Fig. 2 and 3).

In intradural growths, the method of procedure is the following: After the dura has been incised and the growth located, a slip of the dentate ligament, on the side from which the tumor is to be approached, is grasped with mosquito forceps, the slip cut free from its attachment to the inner surface of the dura, and traction made on the forceps. By this means, the spinal cord is raised out of its bed, drawn to the other side, and partly rotated (Figs. 4 and 5). If the growth is not sufficiently exposed, especially if it lies in front of the cord near the mid-line, the corresponding posterior root may have to be divided. As soon as this has been done, the cord can be still further pulled to one side

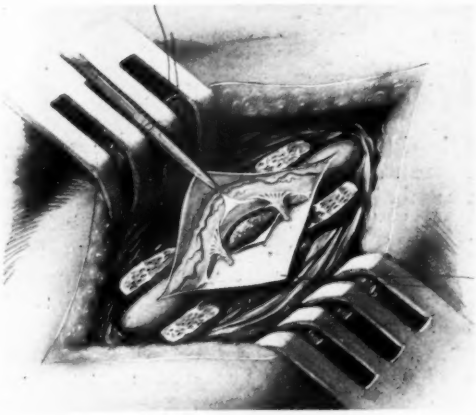

Fig. 8. Removal of extradural tumor by the transdural route. Incision of the anterior layer of the dura and exposure of the tumor.

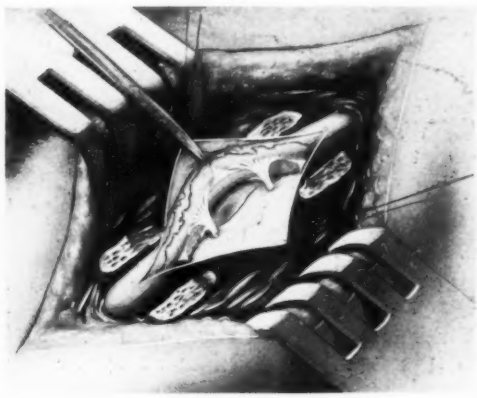

Fig. 9. Removal of extradural tumor by the transdural route. Condition after removal of the tumor.

(Fig. 6). These procedures usually suffice to bring the entire tumor into view. During its removal, the retraction of the cord is continued by an assistant, and the operator proceeds with the extirpation of the growth by working from the mesial aspect of the growth toward the side, i. e., in a direction away from the spinal cord.

If the tumor is found to be an extradural one, one of two methods should be followed. The entire dural sac may be drawn to one side and the tumor thus exposed. In this procedure the bleeding from the veins on the posterior surfaces of the bodies of the vertebræ may be profuse and very disturbing, and the manipulations necessary for the control of the oozing (packing, etc.) may mean considerable pressure upon the cord through the dura, especially if the tumor lies near the mid-line in front of the dural sac and cord. In these cases, I have performed a transdural operation and have found it very applicable to extradural tumors in this location.

The steps of the procedure are the following: After the dural sac has been opened and the cord drawn to one side in the manner I have described, the anterior layer of dura is freely incised and the growth thus exposed and removed. The edges of the incision in the anterior dura are then allowed to fall together without any sutures (Figs. 7, 8, and 9).

From my experience, I can highly recommend this transdural approach as one that will endanger the cord less than the extradural procedure. The method is also useful for the removal of a process of bone remaining after a fracture of the spine and projecting backwards from the body of a vertebra.

SOME NOTES IN REGARD TO THE SURGERY OF SOUTH CHINA[1]

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THE following statements concerning the incidence of surgical diseases and conditions are based upon an analysis of 64,938 operative procedures performed upon inpatients in the Canton Hospital during a long term of years and the other data from the records of 13,761 operations performed upon inpatients in the same institution during the past 10 years. Brief notes in regard to a few interesting cases are also added.

The following was the order of frequency in the incidence of disease as affecting the different systems: ophthalmological, 18,734 or 26.7 per cent of the cases; infections, 13,616 or 19.4 per cent; genito-urinary, 11,190 or 16 per cent; tumors, 5,184 or 7.4 per cent; wounds and injuries, 4,743 or 6.7 per cent; bones and joints, 4,526 or 6.4 per cent; digestive, 3,655 or 5.5 per cent; upper tract, 926 or 1.3 per cent; abdomen and wall, 292 or 0.4 per cent; rectum and anus, 2,527 or 3.6 per cent; congenital abnormalities, 2,410 or 3.4 per cent; otological, 2,063 or 2.9 per cent; obstetrical, 1,599 or 2.3 per cent; gynecological, 737 or 0.7 per cent; lymphatic, 464 or 0.6 per cent; circulatory, 234 or 0.3 per cent; rhinological and laryngological, 155 or 0.2 per cent; respiratory, 48 or 0.07 per cent; ductless glands, 11 or 0.01 per cent. During the past 8 years the hospital work has been specialized.

Congenital abnormalities. Phimosis, 1,123 cases; hare-lip, 856; imperforate anus, 230; polydactylism 46; nævi, 34; cleft palate, 14; hypospadias and epispadias, 14; vaginal atresia, 12; webbed fingers, 10; branchial cysts, 7; cephalomengocele, 3; rectovaginal cloaca, 5; patent urachus, 3; teratomata, 3. Patients with hare-lip usually come to the hospital just prior to marriage. The average age for the males with this condition was 21, females 14. A male child, 3 years of age, presented a channel from the bowel, along the inferior surface of the penis, and parallel with the urethra, which gave exit to the fæces at the end of the penis just below the meatus urinarius. A boy with imperforate anus had a canal along the scrotum to the middle. A lower incisor was extracted from a baby 7 days old. One boy was operated upon at the same time for hare-lip, supernumerary thumb, and ear. In one case the radius of both forearms and the thumbs of both hands were wanting. A patient who was almost blind lacked all fingers except the thumbs and little fingers. There was a corresponding deficiency in the feet. The metacarpals and metatarsals were also wanting, except in the case of the little toe of the right foot which had two metatarsals. Another patient lacked all of the part of the right foot anterior to the ankle, there being a deficiency of 25 bones, and of all of the ligaments, muscles, vessels, and nerves. A boy of 7 had his right temple, cheek, and side of his nose covered with a thick growth of hair several inches in length. A child resembling a monkey lived for 10 hours. The face, body, and limbs were well developed. The head receded from the eyebrows backward and downward. The top of the head was flat with an oval space of ulcerated skin with an opening in the bone exposing the foramen magnum and the base of the skull around it. The frontal, parietal, and occipital bones rested on the base of the skull. The spinal column terminated abruptly at the foramen magnum. Only rudiments of the cerebrum and cerebellum existed. Transverse diameter at zygoma, 1.1 inches. Parietal bones, 2. Anterior posterior, 2.6 inches diameter. A boy of 9 had seven toes to each foot, the supernumerary ones being on the inner side of his feet. Both tibias were dislocated at the knee-joints and the upper ends projected obliquely outward, while the shafts were somewhat curved, with the lower ends projecting inward, throwing the soles of the feet inward and upward. The thumbs of both hands were wanting. Imperfect thumbs were attached in their whole length to the inner sides of the index fingers.

[1] Presented at Clinical Congress of American College of Surgeons, Montreal, October 15, 1920.

Fig. 1.

Fig. 2.

Fig. 3.

Fig. 1. Sarcoma of the eye. Removed.
Fig. 2. Sarcoma, recurrence.
Fig. 3. Lipoma in boy, age 11. Duration 9 years. Removed. Weight 4 pounds.

Locomotor. Caries, 2,401; amputations, 667; fractures, 666; dislocations, 469; arthritis, 215; supernumerary digits, 46; gangrene, 36. Tuberculosis of the bones and joints is usually seen between the ages of 10 and 20. Sequestra of from 3 to 5 inches in length were removed from the shafts of the bones of a number of children, usually boys. In most cases the fistulæ promptly heal. In one case the left clavicle which was necrosed, stood out as a bridge, denuded of skin and only attached at the ends. A patient was admitted with an ulcer which refused to heal; a piece of bamboo 3½ inches long, sharp at one end and ½ inch wide at the other, of the presence of which the patient was not aware, but which must have been there for a year, was removed. Gangrene of the feet from compression was sometimes seen. Cases in which the gangrene extended to the ankle, knee, hip, and elbow were treated. Sometimes the limb has already sloughed off.

Circulatory. The larger arteries were ligated 140 times, 34 for aneurism. There were 58 aneurisms, a few successfully cured by endo-aneurismorrhaphy; 34 angiomata; 6 varicose veins. This is quite a common condition, but as it does not cause pain or disability, operation is not desired. Two tumors of the carotid body were excised. One patient had an aneurism of the thoracic branch of the axillary artery, external to the ribs, extending from the clavicle to below the nipple and from the axilla to the sternum. This condition is most frequently seen in males, and at the average age of 38.

Digestive, upper tract. Thirteen ranulas; epulis, 32; cancer of the lip, 10; cancer of the tongue, 5 (many cases seen are inoperable); foreign bodies in the œsophagus, money, false teeth, bones, 10; stricture of the œsophagus, 3. Interference with the functions of mastication, deglutition, and respiration usually impels the patient to come to the hospital sooner or later. The causes may be a large fibroma of the upper lip, macroglossia filling and extruding from the mouth, bony ankylosis of the maxillæ, sarcoma of the superior maxilla which usually distends the cheek and completely fills the mouth so that the jaws cannot be closed, with displacement of the nose and mandible. The antrum may be cystic and

Fig. 4. Congenital tumor, patient 1 day old. Removed successfully.

greatly distended or a large polyp in the antrum may be the cause. Tumors of the inferior maxilla, odontoma, osteosarcoma, cyst, or necrosis with abscess may be the cause. Multiple polyps, so large as to cause absorption of the nasal and submaxillary bones and bulging of the face and to fill the posterior pharynx, may become malignant.

Abdomen and wall. Hernia. Inguinal, 74; ventral, femoral and labial, 26; traumatic, 8; appendicits, 30; liver abscess, 34; acute general peritonitis, 10; tubercular peritonitis, 16; splenectomy, 5; intestinal obstruction, 7; intra-abdominal abscess, 5; carcinoma of the stomach, 5; tubercular adenitis, 3; gastro-enterostomy for gastric ulcer, 2 (this condition is fairly common, but the patients are cured by the physician); incised and stab wounds, 20; foreign bodies extracted, 18; fœcal fistulæ, 16; a few cases of adhesions; one cyst of the mesentery; intussusception, 2. In 43 exploratory laparotomies the condition was found to be inoperable. In many cases it does not require an operation to determine this. Gunshot wounds of the abdomen are frequently treated, usually late, often exsanguinated. The average age of the patients with inguinal hernia was 35 years. In a case of ventral hernia complicated with ascites and diseased ovaries, the hernia extended half way down to the woman's knees. To relieve his suffering a man with strangulated hernia made a deep vertical incision with a razor which divided the transverse colon for three-fourths of its circumference. A few cases of fæcal fistula secondary to hernia, usually in males, about 35 years of age, were treated, and there were several cases of this condition resulting from congenital hernia, umbilical and inguinal. A female patient had incarcerated inguinal hernia. A woman of 40 had a wide deep ulcer in the left iliac region. She reported that native medicine men had applied medicines for one month, after which a worm over 10 inches in length came out. Cutting open the belly with a piece of porcelain, more than one hundred little worms came out. The ulcer then closed.

Rectum and anus. Fistula-in-ano, 1,073; hæmorrhoids, 1,101; imperforate anus, 230; stricture of the rectum, 67; prolapse, 45; cancer, 9; one polyp. In one case a native physician was applying ointment with a large stick which slipped into the rectum. A large club was forced into the rectum of one patient as a punishment for adultery.

Genito-urinary. There were 3,500 operations for calculus of the urinary organs, of which 2,970 were vesical, 409 urethral, 116 preputial, 5 renal; hydrocele 1,858; stricture of urethra, 1,045; chancroid and bubo, 610; cancer of the penis, 207; extravasation of urine, 93; orchidectomy, 39; elephantiasis, 81—scrotum, 31, 15 each of the penis and labia, and 8 of the leg; foreign bodies in the bladder, 18, including needles, catheter fragments, gauze, sticks; hypertrophied prostates, 6; malignant growths of the bladder, 6; tubercular bladders, 4, 2 of which were ruptured; papillomata, 3; many gunshot wounds; 15 kidneys were decapsulated with temporary relief of symptoms. The cases of malformation of the penis are usually brought to the hospital at puberty. Venereal diseases are most common among soldiers and the leisure class. Gonorrhœa, primary and secondary syphylis, and chancroid and bubo are usually seen in both males and females between the ages of 25 and 30 and stricture at 40. A patient with calculus impacted in the urethra had retention for 7 days; 1½ gallons of urine and pus were removed. A male, aged 63, with phimosis from infancy had 40 preputial calculi. One calculus contained a portion of a beanstalk 6 inches long, introduced by mischievous boys while he was asleep. A boy introduced a needle 2 inches long into his urethra; it slipped into his bladder, and formed the nucleus for a stone.

One calculus, 3 by 1 inch was bent to a right angle. A male, 24 years of age with a 12-ounce stone had symptoms for over 20 years. A farmer had lithotrity performed upon him five times. A boy of 7 had his bladder divided by a septum into two compartments, each of which contained a stone. Another with 10 years' duration of symptoms, had two calculi in the urethra. The bladder was divided into two cavities by a septum, with a stone in the anterior one. Thirty stones were contained in a sac below the neck of the bladder, and a single one in the bladder in another case. One patient had a stone in a urinary fistula and another one in the bladder. A patient with a 10-ounce stone had marked kyphosis. A brass ring which had been buried in a ulcer for 10 days was removed from around the penis of a boy. In a case of syphilis the penis was entirely gone and there was a large opening into the bladder.

Glandular. Three hundred and eighty-three cases of tubercular adenitis, usually cervical, went to the operating table for block dissection. Of goiters, there were 8 parenchymatous, 1 exophthalmic, and 1 with abscess. In the adjoining province this condition is very common. Most of the cases we see are intrathoracic.

Infections. Abscesses, large, 10,874; ulcers, 2,647; carbuncles, 70.

Respiratory system. Twenty-one cases of empyema, usually due to gunshot wounds; 4 of abscess of the lung. Eight cases required tracheotomy, 1 laryngotomy.

Tumors. There were 5,184 tumors, including 525 cases of carcinoma of the breast, 17 neuromata, and 3 teratomata. Seventy per cent were benign and 30 per cent malignant. A male of 40 had a large tumor, shaped like a violin, attached to his shoulder, with circumference at the base of over 3 feet, length of 2 feet, and width of nearly 2 feet. He spent most of the time reclining upon his tumor. Another presented himself at the hospital with a tumor attached to his back and extending nearly to the ground. It was over 4 feet in circumference and probably weighed from 75 to 100 pounds. When he sat down it formed a large circular cushion that elevated him 8 inches. It was proposed to remove it,

Fig. 5. Congenital tumor. Removed.

but his idol, which he consulted, decided against it. A young woman had a tumor attached to the chin and throat, more than 2 feet in circumference which weighed 16 pounds. A male of 50 presented lipomata of both cheeks of the same size, about 10 inches in circumference, hanging pendulous. A male of 49 was covered from head to foot with molluscum fibrosum, from the size of a pea to one foot in circumference. In the case of a woman with elephantiasis of the vulva of 10 years' duration, the mass hung half way to the knees. A farmer, 41 years of age, had an enchondroma, 1 foot in circumference, forming a perfect sphere, surrounding the middle finger of the left hand. Patient had tumor of the foot, which had grown for 10 years, covering most of the dorsum of the foot and passing to the plantar surface, between the first and second metatarsals, separating the toes for 2 inches. A female of 38 had a tumor of the breast of 10 years' duration weighing over 9 pounds. A male of 43 had cancer of the breast, duration 1 year. A male patient had a tumor of the median nerve the size of an orange. A female, 45 years of age, had a cauliflower-like tumor attached to and growing out of the nipple, which had dragged down the breast until it was suspended by a long pedicle reaching below the umbilicus. A male of 33 had hypertrophied cavernous bodies, which had commenced to grow when he was 6 years of age. The enlargement was 4 inches in diameter. The patient was married but never had erections, emissions, or children. A

Fig. 6. Elephantiasis of the vulva. Removed.

teratoma weighing about 5 pounds, with length of 12 inches and greatest circumference 17 inches consisted of a fœtus in which the development had been arrested early in the fifth month of intra-uterine life. A broad attachment to the living child extended from the anterior portion of the trunk.

Wounds and injuries. Gunshot wounds, 1,380; incised and stab wounds, 364; burns and scalds, 313; foreign bodies extracted, 323, including 100 needles, 27 bamboo sticks, and 26 miscellaneous articles such as rings, catheter fragments, coins, bones, gauze, sticks; from the eyelid, hand, finger, œsophagus and trachea, bladder, uterus, rectum, stomach, colon. Three hundred and thirty-nine bullets were extracted. There were 42 powder burns. Eight patients were gored by water buffaloes. Ten were bitten by snakes, dogs, pigs, and human beings. One was clawed by a tiger. There were 97 bomb wounds.

Gynecology. Three hundred and sixteen cases of ovarian adenocystomata were operated upon. There were also 6 ovarian dermoids, 6 parovarian cysts, and 3 papillomata of the broad ligament; 42 vesicovaginal fistulæ; perineorrhaphy (delivered outside) required in 91 cases; uterine fibroids, 25; prolapsus uteri, 22; salpingitis, 9; repair of lacerated cervix, 40; hydatid mole, 5; hysterectomy, 28; vaginal atresia, 12; pronounced retroverted uterus, 15; rectovaginal cloaca, 5; labial tumors, 5; carcinoma of vulva, 3. Ovarian cysts are seen in girls of 17 and women of 60, the average age being 30 years; abdominal girth from 35 to 72 inches; weight of tumors from 10 to 116½ pounds; duration of symptoms, when patient first noticed enlargement of the abdomen until admitted to the hospital, from 3 months to 20 years, average 3 years. A girl of 17 had a cyst which weighed 70 pounds, about a fourth of which was solid. No uterus was found in a girl with imperforate vagina. Several cases of bicornuate uterus were seen. A female of 21 had an abdominal tumor the size of an orange, situated 3 inches below the umbilicus in the mid-line. When 10 years of age she had noticed a lump in the abdomen which was movable. An abscess had formed and discharged large quantities of pus, flesh, and hair. Native doctors (so called) had applied caustics, making fistulæ which had also discharged pus, hair, and three teeth.

Obstetrics. Normal deliveries, 875; forceps deliveries, 432; version, 184; retained placenta, 114; craniotomy, 93; miscarriages, 52; placenta prævia, 33; transverse presentations, 16; twins and triplets, 7; cæsarean section, 5; ruptured uterus, 5; prolapse of uterus, 8; retroverted gravid uterus, 2. A female, 24 years of age, had malaria with ascites and was supposed to be dying; a coffin and shroud were therefore provided and placed by her bedside. Labor commenced, and she was brought to the hospital. An enchondroma had grown directly across the pelvis originating from the tuber ischii. Cæsarean section was performed and a 4½-pound girl removed. In a case of twin pregnancy, the first child had been born naturally; the arm of the second presented, the uterus ruptured and the child had partly passed into the abdominal cavity. It was necessary to remove a dead fœtus from the uterus of a woman with smallpox, covered from head to foot with scabs, who had not been cleaned since the commencement of her sickness 2 weeks previous.

Ophthalmology. Entropium, 12,585; cataract, 3,052; pterygium, 1,385; iridectomy, 1,091; enucleation, 140; glaucoma, 72; tumors of the orbit, 61; foreign bodies extracted, 52; hypopyon, 40; staphyloma, 37; strabismus, 19. A male of 60 with dimness of vision in the left eye presented a white spherical body with a tail-like appendage in the anterior chamber, which was found to be a hydatid. In an infant of 2 months, the inner half of both upper eyelids were wanting and pterygia

extended from both eyeballs to this part of the lids.

Otology, rhinology, laryngology. Nasal polyps, 641; tonsillectomy, 116; rent ears, 1,471; aural tumors, 32; radical mastoid, 8; occlusion of the nares, usually from smallpox, 20; sinusitis, 22. A sixteen year old boy was without an external ear or meatus.

Because of its spectacular results, surgery has made more rapid progress in the confidence of the people than medicine. During the past 10 years, although many advanced pathological conditions and inoperable cases are still seen, many more of operable abdominal conditions and acute cases have steadily been observed. Injuries from machinery and gunshot wounds, inflicted during the revolutions and by the ubiquitous robbers and pirates, and in clan fights are more frequently treated, and are brought to the hospital at earlier stages. Pain or serious disability usually drives the patient to the hospital. Many of the patients are afflicted with a variety of diseases and conditions, concomitant, or complications. The greater number are infected with intestinal parasites. Physiological standards for the Chinese people are being worked out.

DIVERTICULUM OF THE ASCENDING COLON

By R. O'CALLAGHAN, M.D., F.A.C.S., Calgary, Alberta

THE patient from whom this interesting tumor was removed was a female, age 68, married, and the mother of 7 children. Until 5 years ago she had always been healthy, and the menses had been normal. Five years ago patient was victim in a disaster in Halifax and received serious injuries consisting in contusions of the abdomen and body. She was very sick and was kept in bed for several weeks without any special treatment. Since the accident she has noticed a swelling in the abdomen which has seemed to come and go, appearing first in one place and then in another. She did not suffer pain and was not markedly constipated. She had not consulted a physician during these attacks. Two days before she called me, she was taken with sudden severe abdominal pain which was localized in the right lower quadrant; she vomited and was constipated. On the third day she became worse and because of a rise in temperature she decided to consult a physician.

Physical examination showed a well developed, somewhat obese adult, who looked sick and was propped up in bed. Her temperature was 102°; pulse 120. Her tongue was coated, teeth poor. Examination of heart and lungs was negative. The bowels moved just before the attack of pain 2 days ago. The abdomen was very fleshy and moved slightly on respiration. In the right lower quadrant a distinct fullness could be seen. On palpation the abdomen was slightly tender throughout but over the right lower quadrant, in the region of the tumefaction about the level of McBurney's point, a very acute tenderness was elicited. The mass was slightly movable, dull on percussion, and about the size of a fœtal head. On palpation it did not feel like an abscess but resembled rather a cyst or tumor.

Vaginal and rectal examination was negative, as the mass did not extend low enough to be palpated through these routes. The uterus was normal and moved freely.

Urinalysis showed specific gravity 10.18; albumin, acid reaction, pus, no blood. The kidneys were not palpable. To exclude floating kidney with pyonephrosis a bilateral catheterization was done. Both kidneys functioned well and only a small amount of pus and a trace of albumin was found in the urine from each.

Examination of the blood showed: white blood cells, 14,000; red blood cells, 4,800,000; polymorphonuclears, 80 per cent.

Enemata were given but produced no results.

From the above examination it was difficult to make a definite diagnosis. There appeared to be partial obstruction; the mass might be an ovarian growth with twisted pedicle or a malignant growth of the colon. We felt satisfied it was not an appendiceal abscess.

Operation. Through a long right rectus incision below the umbilicus, the abdomen was opened. We found some serous fluid in the cavity but no pus. The mass was soon located. At first, it resembled a cystic ovary. Only a small piece of it was visible but the remainder of it was found wrapped in the small intestine and omentum. After gradually separating the adhesions we found that the mass extended upward, not downward into the pelvic region. When separating the intestine from the mass with a sponge, the tumor collapsed with the noise of escaping gas. The mass proved to be a large obstructed diverticulum of the ascending colon. The latter was in itself very mobile and accounted for the changing position of the tumor. The

Photograph of specimen.

diverticulum evidently filled and emptied according to the patient's history and this accounted for the disappearance of the tumor at times. In the present attack it had evidently closed off at the base and became a sac of fæcal matter with gas causing partial obstruction, temperature, and general signs of toxæmia.

I removed the mass by placing a small clamp on the colon and resecting. The wound was closed in the usual manner without drainage. The patient made an uneventful recovery.

Pathological report by Dr. Leacock, pathologist, Holy Cross Hospital, Calgary: In gross appearance the sac removed from the bowel is of large pear shape. It is 13 centimeters long and 6 centimeters in width. The upper, larger, end is very thick walled and has a very thick fibrous opening about 2 centimeters in diameter at the extreme end. The lower, smaller end of the sac is thin walled and blind. The sac has been opened and contents have been evacuated. (It was said to be filled with fæcal material.) Specimen preserved.

Microscopic examination shows the wall of the sac composed of fibrous tissue and some loose connective tissue, with scattered areas of small round cells. No glandular layer is to be seen.

I feel that this case should be reported for, although diverticula are becoming more easily recognized, they are not usually found in the ascending colon. They are more often found in the sigmoid, transverse, and descending colons. The diverticulum in this case evidently followed directly on a severe injury to the abdominal wall, and there is a possibility that at that time the bowel wall partially ruptured.

It is quite conceivable that many of the men returned from overseas who suffered while there with symptoms of peritonism without any definite rupture, may later develop diverticula. In many cases also exploratory laparotomies were done and the intestines repaired; in others, abrasions or even ruptures were overlooked which of necessity must leave weak walls of the intestinal muscular coat. As Binnie points out in his *Regional Surgery* there are points of weakness in the muscular coats of the colon in many individuals and these points are often starting points for diverticula. Many cases of diverticulum of the colon are I believe explored under a diagnosis of malignancy of the colon. In this case such a contingency was naturally taken into consideration in the differential diagnosis although there had been no common symptoms of such and the patient showed no signs of cachexia or failing health that would be expected to be present in a malignant growth of that size.

DISCONNECTING GASTRO-ENTEROSTOMY STOMATA

A Clinical and Experimental Study[1]

By ROSCOE C. WEBB, M.D., F.A.C.S., Minneapolis, Minnesota
Associate Surgeon, University Hospital
From the Department of Surgery of the University of Minnesota

THE gastro-enterostomy operation is today so thoroughly standardized that it has become, in the hands of one experienced in surgical technique, to be considered a relatively safe procedure. When indicated, this operation gives very satisfactory results and is given much well deserved praise. However, the extensive use of this form of treatment has occasionally led to its abuse, and today in every large surgical clinic cases appear in which we find that at some previous time a gastro-enterostomy has been done, that there has not been a relief of symptoms, or that the condition of which the patient was complaining has been made worse, and the patient desires to have the previous operation undone. After considerable careful study it may finally be found that there was no indication for the operation in the first place and the patient is submitted to a second operation in order to give relief. Occasionally it is only at the second operation, after careful exploration of the stomach, that one can finally decide that the first operation was not indicated and the gastro-enterostomy must be disconnected.

The patient usually presents symptoms of a vicious circle with continuous and frequent vomiting of bile-stained material, and abdominal pain and distress. There seems to be no non-operative relief for the condition.

There are numerous methods used in disconnecting these cases, but there is as yet no standardized procedure. The chief questions are, first, the restoration of the organs to their normal position and mobility with as few adhesions as possible, and second, the prevention of constriction of the lumen of the jejunum. The stomach is capable of taking care of itself provided it is disconnected, released from adhesions, and properly closed. The care of the jejunum is left for consideration. If the disconnecting incision is made along the line of the anastomosis there will be a certain amount of constriction of the jejunum due to the fact that there is a loss of tissue with every intestinal anastomosis. This loss of tissue consequent to the first operation reduces the circumference of the jejunum at this point and when it becomes necessary to invert the jejunum at this point again, as a result of the operation of disconnecting the gastro-enterostomy, the stricture at this point may become serious. For this reason various methods have been suggested for preventing stricture. The method which has seemed most feasible and which has been tried out clinically and experimentally at the University of Minnesota is the method briefly described by Andrews,[1] as follows: After lifting the transverse colon and exposing the line of union to the bowel, the rubber-covered clamps are placed on each viscus, leaving a free space for operation. The incision is made upon the stomach wall 1 centimeter away from the line of anastomosis, leaving a cuff of stomach entirely around the false opening in the bowel. When the jejunal opening is closed there is just enough to bring the bowel to its normal diameter when two or three rows of inversion sutures have been placed. The stomach opening is closed by the usual method and the loss of tissue is of no consequence. The opening in the transverse mesentery is closed to prevent any possible hernia and the operation is completed.

The method has been tried and in three cases proven satisfactory clinically, two cases at the University Hospital and a third case kindly reported to me by Dr. Ritchie of St. Paul, which are briefly reported, as follows:

Case 1. Mrs. F. N., white, housewife, age 23 years, was admitted to the University Hospital March 12, 1920, complaining of inability to retain food, nausea, vomiting, loss of weight, and abdom-

[1] E. Wyllys Andrews. Disconnecting gastro-enterostomy stomas. Tr. Am. Surg. Ass., 1920, xxxviii, 698.

[1] Read before the Clinical Club of Minneapolis, April 21, 1921.

Fig. 1. Dog, Experiment 1. Photograph of distended specimen, fresh. The instruments point to the ends of the closed stoma. Note absence of constriction.

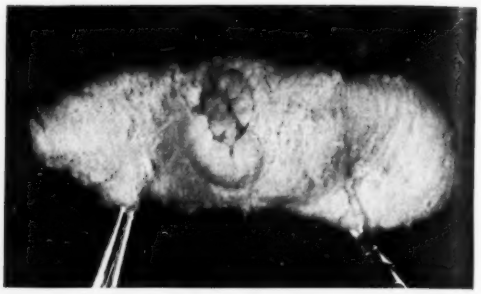

Fig. 2. Experiment 1. Photograph of fresh specimen cut longitudinally opposite to the closed stoma. Note the gastric mucosa surrounded by jejunal mucosa.

inal tenderness. Her family history has no bearing on the case. She has always been well except for occasional spells of headache and vomiting at irregular and infrequent intervals. Thyroidectomy was done when she was 19 years of age, for simple enlarged thyroid; tonsillectomy at age of 22. Aside from occasional attacks of precordial pain suggesting pyrosis, her cardiorespiratory history is negative. Her appetitie has been fair up to time of an attack of influenza in 1918. She has had constipation for the past 3 years. She had a miscarriage with her first pregnancy, but has had two children since who are living and well.

In November, 1918, patient had influenza, from which she dates the onset of her present trouble. Following this she had more frequent headaches, irregular spells of vomiting, constipation, irregular and varying abdominal pains which were not localized. Her appetite was poor and she had pyrosis and gaseous eructations and occasional attacks of vertigo. In October, 1919, an appendectomy and gastro-enterostomy was done. Following this, her symptoms became exaggerated. In addition to her previous symptoms she had attacks of burning urination with diminished output, and in January, 1920, she had an attack of numbness and spasticity in the arms and legs. She has lost 45 pounds in weight. Her vomiting spells have occurred daily of late and have no relation to the taking of food. Weakness has been gradually becoming worse.

Physical examination. Patient is small anæmic woman appearing chronically ill. There is marked evidence of loss of weight and dehydration. Eyes react normally. There is considerable pyorrhœa and the tongue is dry. There is a scar on the neck from thyroidectomy. The heart is not enlarged and the sounds are normal. The lungs are clear on percussion and auscultation. Blood pressure: systolic, 112; diastolic, 72 millimeters mercury. There is an adherent scar in the upper right rectus region. The abdomen is scaphoid, there is no rigidity, but there is moderate tenderness on palpation. Peristaltic waves can be noted in the epigastrium at times. At the region of the lower border of the stomach tympany, there is mass about 2 by 5 centimeters which is somewhat movable transversely and is slightly tender. Pelvic organs are normal. Reflexes are normal.

Urine shows a trace of albumin at times, otherwise normal. Wassermann is negative. Basal metabolism is normal. Blood shows hæmoglobin, 68%; red blood cells, 4,720,000; white blood cells, 9,400; differential normal. Stomach contents: total acid varied from 12 to 35 per cent; free hydrochloric acid absent; bile at time. Fæces: guaiac, negative.

Roentgenological examination by Dr. Allison shows a marked prolapse of the stomach with a gastro-enterostomy opening on the greater curvature and gastric contents passing out of stomach freely both through the pylorus and by gastro-enterostomy. There is no evidence of gastric or duodenal ulcer.

Neurological examination by Dr. Nixon.

Conclusion. From the history, patient has apparently had two definite attacks of tetany. The gastric disturbances are not typically those of tetany but with these attacks it is at least very suggestive that the condition may become gastric tetany if allowed to progress.

After 6 weeks of study and treatment on the medical service during which time the vomiting and abdominal distress continued and patient's general condition gradually became worse, regardless of treatment, she was transferred to the surgical service for operation, for relief of the vicious circle.

Operation, May 8, 1920, by Dr. Law. Old upper right rectus scar dissected out. Dense fibrous adhesions found between omentum, stomach, liver, and anterior abdominal wall. Duodenum and stomach were carefully explored and no ulcer or scars found. Stomach was greatly prolapsed and a gastro-enterostomy opening found which was three times the normal size. Distal to the opening the jejunum

was found kinked and held so by fibrous tissue. Adhesions were freed and the stoma exposed. Rubber-covered clamps were placed on the stomach and bowel and the stomach was incised 1 centimeter distal to the line of union with the jejunum. The openings were closed by an inner layer of catgut sutures, Connell method, and an outer Cushing stitch of linen.

Convalescence was very stormy for the first few days, due chiefly to the extremely poor condition which she was in before the operation. Her wound healed normally and she was able to take the usual diet given to the gastric cases. She recovered slowly but was able to leave the hospital 4 weeks after her operation and was entirely free from her former gastric symptoms.

April 16, 1921, patient returned to hospital by request and was looking well and happy. Her weight before operation was 84 pounds and she now weighs 135½ pounds. She has no vomiting spells and can eat anything. Her appetite is good and her bowels are regular. She is still gaining weight.

Case 2. Miss T. B., age 25, white, was referred to the University Hospital from the University Dispensary March 3, 1921, on account of epigastric pain, frequent spells of vomiting bile-stained material, and loss of weight. Her family history has no bearing on the case. Patient's health was good until the age of 14. She had the usual childhood diseases with no sequelæ. She had typhoid fever at 21. When 16 she had ear trouble and at 19 she had a mastoid operation on the right side and 8 months later the left mastoid was operated upon. Four years later it was found necessary to do the right mastoid operation again. She had ulcers in her nose which were operated upon at the age of 24 and she had her tonsils removed at the age of 20. Aside from occasional cough and some cardiac palpitation at times, her cardiorespiratory history is negative. Her appendix was removed when she was 19 and when 21 a right inguinal hernia was repaired. At the time of the last operation a tumor on the right hip was removed. At the age of 22 a right nephropexy was performed and 1 year later a cyst of the right ovary was removed. She had had "stomach trouble" for several years which was characterized by epigastric pain and frequent attacks of vomiting. The pain had no time relation to meals and was not relieved by soda or by taking of food. Following the oophorectomy she had frequent attacks of vomiting and was unable to take any food. Diagnosis of gastric ulcer was made by her physician and he then performed a gastro-enterostomy, 5 weeks after the oophorectomy, which gave her relief for 4 months. She had had some dysuria and difficulty in starting to void at times. She has occasional spells of frequency and has nocturia three or four times each night. Her menstrual history has been normal. Her operations numbered thirteen in all.

For 3 or 4 months after her last operation, the gastro-enterostomy, she was relieved of the vomiting and pain and then her symptoms recurred and for the past 2 years her symptoms have been nearly constant. She has lost nearly 25 pounds in weight. At first the attacks came on every few days and gradually increased in frequency until the present time when she has three or four vomiting spells every day. Shortly after taking food she has pain which is followed by the vomiting of bile-stained gastric contents. Vomiting simply increases the pain and the attacks continue until she is exhausted. It is not relieved by staying in bed.

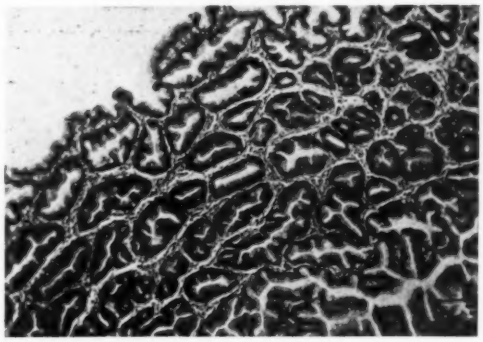

Fig. 3. Experiment 1. Photomicrograph of the transplanted stomach wall, which shows the general conformation of the glandular portion of the wall and the normal appearance of the glands.

Physical examination. Patient is a well developed, well nourished, rather nervous and excitable young woman. Her eyes react to light and accommodation. There are scars behind both ears and the nasal septum is perforated. Her teeth are in poor condition and her tonsils have been removed. The heart is not enlarged and the sounds are normal. There are a few scattered râles in lungs which are otherwise normal. Aside from the abdominal scars the abdomen is normal. There are no masses or acute tenderness. Reflexes are present and active. Pelvic organs normal.

The urine is normal; the fæces, with a guaiac test negative; Wassermann, negative. Hæmoglobin 70 per cent; white blood cells, 11,000. Test meal: total acid, 22 per cent; free hydrochloric acid, 12 per cent; guaiac, positive.

Roentgenological examination of the stomach by Dr. Allison shows a well functioning gastro-enterostomy and no evidence of gastric ulcer.

In view of the absence of any evidence of disease in the stomach, the presence of a gastro-enterostomy and the symptoms of a vicious circle, an operation disconnecting the gastro-enterostomy was indicated.

Operation, March 16, 1921, by Dr. Stiachauer. An incision was made excising the former upper right rectus scar. There was a moderate number of adhesions about the site of the gastro-enterostomy, the opening was of the usual size and in good working order. Rubber covered clamps were placed

Fig. 4. Dog. Experiment 2. Photograph of distended jejunum, hardened in formalin. Instruments point to the ends of the closed stoma. Note absence of constriction.

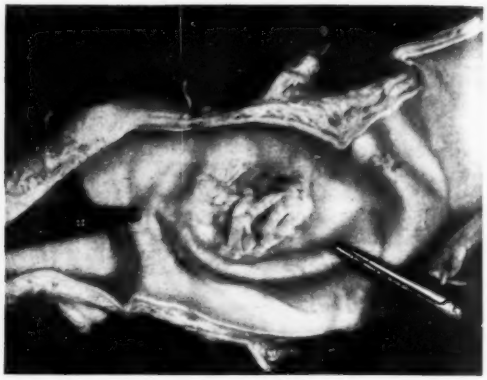

Fig. 5. Experiment 2. Photograph of hardened specimen cut open longitudinally along mesenteric border. Note the gastric mucosa surrounded by jejunal mucosa.

on the intestine at each end of the anastomotic opening leaving sufficient room to work, and two additional clamps were placed on the stomach about a half inch from the line of union with the jejunum. A cuff of stomach 1 centimeter wide was cut off and closed with three layers of catgut sutures. The stomach was closed in a similar manner and the opening in the transverse mesocolon closed. This was preceded by a careful examination of the stomach which revealed no gastric lesion.

Convalescence was uneventful. There was no increase in the pulse rate or the temperature beyond the usual slight reaction. She took the usual diet given to stomach cases and at the end of 2 weeks was taking a light diet and in 3 weeks was taking a general diet with five meals per day. She vomited twice while coming out of ether and vomited once on the nineteenth day following a dose of liquid albolene.

On the twenty-seventh day fluoroscopic examination by Dr. C. B. Wright showed the barium going through in good shape immediately after the meal and there was a marked constriction at the pyloric end of the stomach. (Probably due to the closure of the gastric stoma.) There was no residue in the stomach at the end of six hours.

Discharged one month after the operation feeling well, no vomiting and taking five small meals per day of regular diet.

Case 3. Mr. F. L., age 22, white, a patient under the care of Dr. H. P. Ritchie, of St. Paul, complained of epigastric pain, loss of weight, and vomiting after taking food during the past 3½ years.

His family history has no bearing on the case and his past history is unimportant.

Three and one-half years ago patient began having pain in the epigastrium, burning in character and beginning 2 hours after eating. The attacks were relieved at this time by rest in bed. Three years ago he was operated upon by another surgeon and a gastro-enterostomy and appendectomy were done. The result was only temporary. He is now vomiting and the stomach washings show retained food.

Fluoroscopic examination shows the stomach at the iliac crest. No peristaltic waves can be noted. When the stomach is compressed, barium passes through the pylorus without apparent obstruction. The stomach was much distorted suggesting hourglass contraction, which was later noted on the plates. No evidence of gastro-enterostomy can be noted by passage of barium from the stomach. Conclusions: Normal pylorus and duodenum with no evidence of obstruction. Gastric constriction due probably to non-functioning gastro-enterostomy high up on posterior wall of stomach.

Operation, April 2, 1921, at the Miller Hospital, by Dr. H. P. Ritchie. Old scar excised, adhesions freed, and stomach explored carefully. There was a possible scar at the pylorus suggesting a healed ulcer but it was not palpable. The gastro-enterostomy was antiperistaltic and well done except that it was high on the posterior wall. The stomach was greatly dilated and ptotic. Since the radiographic examination showed no function of this opening it was disconnected by turning in a cuff of stomach wall over the opening in the jejunum. Recovery was uneventful and there was every evidence subjectively and objectively of immediate and complete relief of his symptoms.

With this type of disconnecting operation the question obviously arises as to the ultimate fate of the transplanted stomach wall. Although it is reasonable to suppose that this tissue can be transplanted, it seems that under the conditions of altered blood and nerve supply, and in an alkaline medium, certain changes may take place, and it would be worth while to prove experimentally the pres-

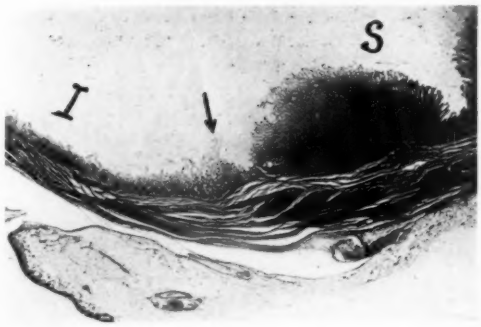

Fig. 6. Experiment 2. Photomicrograph, low power, of line of union of the jejunal wall and the transplanted stomach. The arrow points to the junction of the gastric and jejunal mucosa. The preservation of the various layers of the walls of each can be readily seen. Note the absence of scar tissue. *s*, stomach; *i*, intestine.

ence or absence of changes in the transplanted tissue as well as the ultimate condition of the lumen of the jejunum. If it were simply to become scar tissue it would at least act as a splint to cover in the defect and would prevent any further diminution in the jejunal circumference.

To determine this point the following experiments were undertaken. Gastro-enterostomies were performed and after the minimal length of time in which one might wait for results in a patient the disconnecting operation was performed. Owing to the difficulty in keeping the dogs the experiments were terminated at the end of 11 months. Autopsies were performed about 6 months after the disconnecting operation.

Experiment No. 1, May 15, 1920. Female spitz and collie dog. Posterior gastro-enterostomy 2 inches long, through transverse mesocolon, isoperistaltic, using three rows of sutures posteriorly and two rows anteriorly. Linen was used for the first and last rows and tanned gut for the remaining three rows. Closure in tiers and the dog recovered without complications.

October 25, 1920, 5 months later, the disconnecting operation was performed. The mesentery of the transverse colon in a dog is so short that the disconnecting operation was quite trying due to the difficulty in sufficiently mobilizing the transverse colon. Having mobilized the site of anastomosis, the opening was found to be satisfactory and working. Two rubber-covered clamps were placed on the jejunum at either end of the anastomosis and a third clamp was placed on the stomach about 1.5 centimeters away from the line of anastomosis,

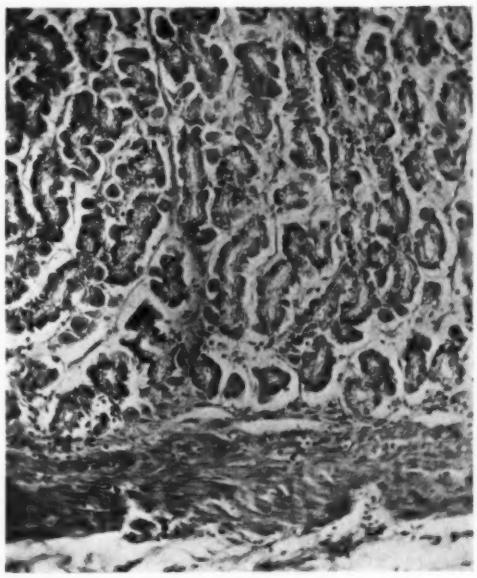

Fig. 7. Experiment 2. Photomicrograph, high power, showing the glands in the transplanted gastric mucosa. The chief and parietal cells can be readily seen and there is no apparent increase in the intertubular connective tissue. The cells appear normal.

and the stomach was cut away leaving a cuff of stomach tissue which was about 1 centimeter wide at the widest point and was slightly narrower at the ends of the jejunal opening. The stomach was closed with three rows of catgut sutures and the opening in the transverse colon was sutured. On examination of the jejunal opening there were no ulcers and the line of union of the stomach tissue and the intestinal wall was plainly visible and well healed. Closure was made with one row of Connell sutures and a second row of Lembert sutures. When completed the diameter of the intestine at this point was about normal. The animal recovered without complications.

April 8, 1921, *Autopsy*, 5½ months later. There was a moderate number of adhesions about the site of operation. No evidence of obstruction or constriction of the lumen of the jejunum (Fig. 1). On opening the gut longitudinally opposite to the line of suture the transplanted gastric mucosa was of normal appearance and had not decreased much in size (Fig. 2). Sections made which include the intestinal and gastric walls (Fig. 3), show normal appearing gastric mucosa and no increase in the connective tissue.

Experiment No. 2, June 3, 1920. Female terrier dog. Posterior gastro-enterostomy, 2 inches long, anterior to the transverse colon isoperistaltic, three rows of sutures posteriorly and two rows anteriorly, using linen for the first and last rows and tanned gut for the other three. Closure of the abdominal wall was done in tiers. Patient made uncomplicated recovery.

October 18, 1920, 4½ months later, a disconnecting operation was performed. Gastro-enterostomy opening was found to be open and in good working order. There was a moderate amount of omental adhesions about the site of the anastomosis which was easily mobilized. Curved rubber-covered clamps were placed on the jejunum at either end of the anastomotic opening and two rubber-covered clamps were placed on the stomach from each side about a half inch away from the line of the opening. The stomach was then cut away leaving a cuff of stomach tissue which was 1 centimeter wide at the widest point and was slightly narrower at either end of the jejunal opening. The narrowing of the cuff at either end prevents the formation of blind pouches at each end of the line of closure in the jejunum. The stomach was closed with three layers of tanned gut sutures. The opening in the intestine was closed with two rows of Lembert sutures. When the closure was completed the gut was of normal size and there was no evidence of constriction at the site of the former opening. The stomach flaps were anæmic but bled slightly and appeared viable. Uncomplicated recovery.

Autopsy, April 1, 1921, 5½ months later. There was a moderate number of omental adhesions about the jejunum at the site of operation. There was no evidence of obstruction or constriction of the lumen of the jejunum (Fig. 4). On opening the jejunum longitudinally the transplanted gastric mucosa was of normal appearance and was but slightly decreased in size (Fig. 5). Sections made which include the intestinal and transplanted gastric walls (Figs. 6 and 7) show that the transplanted stomach tissue has retained its normal appearance and the various layers can be readily made out. The high-power figure shows the normal appearing glands without increase of the intertubular connective tissue. The chief and parietal cells of the gastric glands retain their staining properties.

The two experimental cases cited show that the method of using a cuff of stomach wall is sound in principle and accomplishes all that is intended without harm to the structures involved. It is of interest to note the preservation of the stomach tissue although transferred from an acid to an alkaline medium and deprived of its original blood and nerve supply.

CONCLUSIONS

Gastro-enterostomy should not be performed without demonstration at the time of operation of the definite indication or lesion.

Disconnecting gastrojejunal stomata should be preceded by most careful clinical and laboratory studies.

From the three clinical cases cited it is seen that the closure of gastro-intestinal anastomoses may be often indicated, and that it is a safe procedure.

The results in the three clinical cases and the two animal experiments prove the value of the use of a cuff of stomach wall and the efficiency of the method to prevent constriction.

The Andrews operation with the slight modifications suggested should become a standardized procedure as long as the indiscriminate use of gastro-enterostomy, without indication, is continued.

MYCETOMA

Report of a Case[1]

By H. L. D. KIRKHAM, M.D., F.A.C.S., Houston, Texas

MYCETOMA, though known and described by ancient Indian writers, has been considered quite rare and looked upon as essentially a disease of India. It is possible that it is not as rare as has been supposed, especially in tropical and semi-tropical countries. Probably many cases of mycetoma have been incorrectly diagnosed elephantiasis, and vice-versa. But since we have learned more of its pathology, this should not occur.

It was first described as a distinct disease in Bret's *Surgery*, in 1840; but many early writers considered the disease as tuberculous. Its parasitic nature was first suggested by Ballingall in 1855, but it was not until 1874 that V. Carter found the causal organism. Cultural methods at this time were crude, and though cases were reported by Bassini in Italy in 1888, by Vincent in Algeria in 1894, and the first case in Canada by Adami and Kirkpatrick in 1895, many of these were regarded as identical with actinomycosis, and it was not until 1906 that Brumpt published a paper showing that actinomycosis was a separate and distinct disease from the other varieties of mycetoma which are caused by separate varieties of fungi.

This disease is distributed throughout the world; but, due to its prevalence in India, it has always been regarded more or less as a disease peculiar to that country. From the number of cases reported from the different parts of the world, and especially from the Southern States and Central America, it is very probable that its incidence is of far greater frequency than is generally supposed; and it is also probable that many cases are incorrectly diagnosed as actinomycosis.

ETIOLOGY

Most commonly we have a history of some injury sometimes insignificant which allows the fungus to enter the subcutaneous tissues. The disease is most commonly seen in the foot, hence its name, Madura foot; occasionally it is seen in the hand and rarely in other regions.

There are two main types of the disease dependent on the color of the granules which can be expressed from the lesions; namely, white and black. However, there are many strains of mycetes which have been classed as causative. The following classification with the date and name of its discoverer, is perhaps the most complete.

GENUS		SPECIES
Ascomycetes	Aspergillus	A. Nidularis (Eidam) 1883.
		A. Bouffard's (Brumpt) 1906.
	Ospora	O. Tozeuri (Nicolle & Pinoy) 1907.
Hyphomycetes	Discomycetes	D. Bovis (Harz) 1897.
		D. Maduræ (Vincent) 1894.
		D. Asteroides (Eppinger) 1890.
	Madurella	M. Mycetomi (Laveran) 1902.
	Indiella	I. Mansoni (Brumpt) 1906.
		I. Reynieri (Brumpt) 1906.
		I. Somaliensis (Brumpt) 1906.

With the exception that the discomyces bovis lives in spiklets of various cereals, little is known of the saphrophytic life of these fungi. It is most common in the barefoot races in the poorer class, and in males.

PATHOLOGY

Essentially this disease is a hyaline degeneration and necrosis which attacks all tissues, even at times the bones, with a formation of fibrous tissue with giant and epithelioid cells and little attempt on the part of the body at reaction. Due to the very complete pathological report of the reported case, nothing will be added here.

SYMPTOMATOLOGY

The disease usually begins in the foot following an injury often insignificant; but

[1] Read before the Texas Surgical Society.

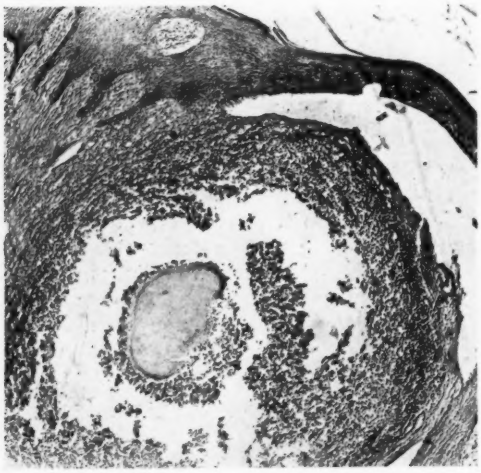

Fig. 1. Colony of actinomyces maduræ under the epidermis.

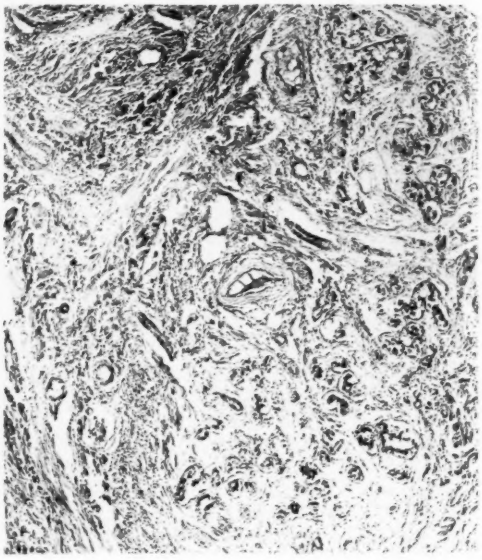

Fig. 2. Fibrosis and round cell infiltration surrounding a sweat gland.

sometimes the hand, leg, neck, or trunk may be affected.

Soon after the original wound is healed, there is swelling and pain in the affected part with a blackish discoloration of the skin, and the formation of hard lumps which have a tendency to bleed and show the formation of sinuses which discharge an oily fluid containing the characteristic granules. In different parts of the foot, new nodules appear and the foot swells until it is ultimately converted into a more or less shapeless mass. The patient frequently complains of a sensation of foreign body in the foot. In most cases the dorsum of the foot seems more affected than the plantar aspect. Practically no effect is noticed upon the system in general. The condition often lasts for years, or until the part becomes so swollen that the patient is incapacitated from walking.

DIAGNOSIS

The diagnosis is based on the peculiar swelling of the foot with the formation of sinuses which discharge the characteristic sclerotia. The diagnosis is confirmed by isolating the fungus and can be grown on ordinary media and is a facultative aerobe. On glycerinated agar it forms discoid colonies white in the center, reddish at the periphery. The mycelian threads and spherical bodies are gram positive, but not acid fast. It must be differentiated from tubercular disease of the foot, actinomycosis, and elephantiasis.

PROGNOSIS

The disease is incurable unless treated surgically.

TREATMENT

In well marked cases amputation affords the only hope of relief. Unlike actinomycosis, iodide of potash in even large doses, has no effect.

CLINICAL HISTORY

Working diagnosis: mycetoma; final diagnosis: mycetoma. Patient, age 22; male; nationality, Mexican; occupation, laborer; present address, Houston, Texas. The family history is unimportant. Patient has had the usual diseases of childhood, otherwise had always been healthy. He denies all venereal history. Does not use alcohol; smokes cigarettes. The present trouble began 11 years ago when the patient, while barefooted, jumped a ditch and received a slight injury to the third toe of the left foot. The patient states that there was no abrasion or break of any kind of the skin. There had been no injury to this foot previously, to the knowledge of the patient. Following this injury there was slight pain, and in about 3 weeks he noticed a

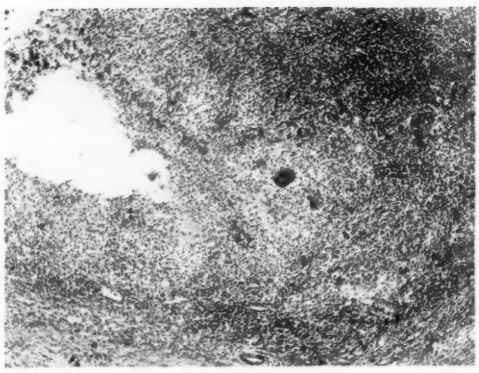

Fig. 3. Area of round cell infiltration showing two giant cells, one of which is in the center of the field. A fungus colony has been torn out of the space at the left.

blackening of the skin on the dorsum of the injured toe, and there soon appeared a "boil" which gave up a small amount of white, pus-like material. The blackened area persisted, and in the one year's time had extended to the adjacent toes, and throughout a semicircular area radiating from the base of the injured toe. Also there had appeared three or four nodules, which soon began to suppurate and give up a white or yellowish white and bloody fluid. Three or 4 years from the date of the original injury the patient first noticed small yellowish bodies in the exudate. These bodies were rather hard and about the size of a pin head. The area of involvement gradually extended, new nodules appearing as the zone of discoloration approached the ankle. At no time did he feel any great pain, but a slight pricking sensation was noticeable at times, especially at night. The patient states that his foot feels as if something were in it. He has been working up until the past few weeks, when the size of his foot interfered with walking.

General condition, temperature 98.2°; height 5 feet, 8 inches; weight 120 pounds; pulse 76, full and regular; respiration 16; patient fairly well nourished. There is slight anæmia of the conjunctivæ, the tonsils are somewhat enlarged, the teeth in good condition.

The lungs and heart are normal. The abdomen is slightly scaphoid, otherwise negative. The genito-urinary system is normal. The urine is of light amber color; with acid reaction; specific gravity 1020; albumin negative; sugar negative; acetone negative; indican negative. Microscopically there are a few epithelial cells; urates; few leucocytes; débris; no casts.

Blood count: reds 4,200,000; hæmoglobin 85 per cent; whites 7,800. Differential: polymorphonuclears 71 per cent; small mononuclear leucocytes 7 per cent. Transitional 1 per cent. Eosinophiles 1 per cent.

Fig. 4. Area of young granulation tissue replacing an inflamed area.

Examination of the skin, bones, and joints, is negative except that the left foot is greatly swollen and misshapen. On the dorsum the skin is blackened, and near the ankle it gradually fades into the normal color. Distally are warty growths and nodules, some as large as a fifty cent piece, covered with a thin, yellow crust. Just proximal to this area are several slightly raised areas, one of which on incision gave up a fluid mostly blood. One of the suppurating nodules on incision gave up small yellowish granules. The plantar surface of the foot is clear of discoloration, and shows nodular growths only in the region of the third toe, and one inch posterior to the tarsophalangeal articulation of the great toe. The apices of these nodules are marked by sinus openings.

The foot was amputated under ether anæsthesia in the lower third of the leg by a long posterior flap and short anterior flap.

Recovery was normal, the wound healed by first intention; convalescence showed no untoward symptoms. After 6 months the patient appears perfectly normal.

PATHOLOGICAL REPORT

A. Gross pathology. Left foot specimen with leg trimmed off 2 inches below malleoli. Foot in good state of preservation except that the epidermis of the sole is macerated and nearly all peeled off. A couple of deep incisions 3 or 4 inches long have been made in the sole, and another 1½ inches long near the inner malleolus evidently to facilitate penetration by formalin.

The anterior half of the foot has a markedly swollen appearance which extends to and includes the

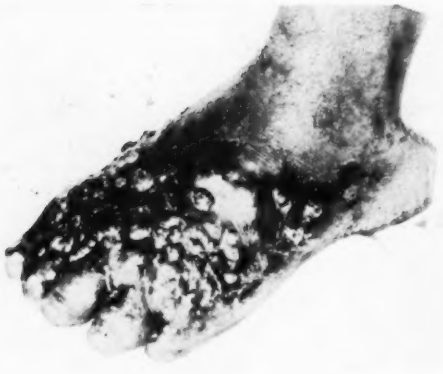

Fig. 5. Patient's foot before removal.

toes. The heel and ankle appear normal. The toes are not separated. While some of the swelling is observed on the plantar aspect, the most is apparent dorsally. The foot is not discolored.

Dorsum. On the dorsal aspect of the foot, extending posteriorly for about 2 inches from the insertion of the toes, are numerous tubercular nodules of a round or oval outline, with coarse granulations about 4 millimeters in heighth, and varying from 2 to 25 millimeters in diameter. Their borders are either perpendicularly elevated or slightly overhanging with a granular summit, or else the whole nodule is convex. They are most numerous at the base of the second toe nearly to the nail. On the inner side of the dorsum, some extend over 2 inches anterior to the base of the great toe; on the outer side a few extend posteriorly to the vertical plane of the external malleolus. Where most abundant they are in close contact and the largest mass, between the bases of the second and third toes, is apparently made up of a coalescence of several. The apex of many is ulcerated, and in some of the ulcers mark the opening of definite sinuses extending into the foot. The color of these nodules is lighter than the healthy skin.

Plantar. A nodule similar to the foregoing may be observed on either side of the third toe. None are observed on the sole, except a small cluster about 1 inch posterior to the tarsophalangeal articulation of the great toe. These masses protrude through the epidermis of the sole, which seems to be punched out of their base, and does not extend over their summit. These are yellowish in color, and the apices of several are marked by sinus openings. The foot was divided into eight sections by vertical and oblique sections. It was necessary to use the saw to cut the bones in every section made.

B. Internal Pathology. The subcutaneous fat on the plantar aspect appears normal in amount throughout the length of the foot, but has disappeared from the dorsal aspect. The tendons of the plantar aspect are readily discernible, but are less readily made out on the dorsal. The muscles have almost entirely disappeared. The place of the dorsal subcutaneous fat is occupied by a dense mass of connective tissue, extending clear to the bones. The bony tissues along the line of the sections are apparently unchanged.

On the dorsum of the foot, embedded in the strands of connective tissue, are numerous sinuses, some single, some lying in groups, each group surrounded by strands of connective tissue. Their diameter varies from 1 to 2 millimeters; but, in places they may be expanded 4 millimeters. A few are filled with a translucent, coagulated, albuminous material, others appear empty, while others appear with a yellowish, necrotic débris. In others are observed yellowish, mulberry shaped granules, apparently filling the entire lumen of the sinus. These sinuses extend up into the nodules on the surface of the skin, but extend in every direction within the substance of the foot. The sinuses appear to be lined by a yellowish, necrotic membrane, which appears thicker where the tunnels are massed together. A few poorly developed sinuses are observed near the bony arch. The tuberculations on the skin, when cut across in sections, appear to be inverted cones with their apices embedded from 5 to 10 millimeters deep in the connective tissue.

On the dorsum, near the ankle, the connective tissue appears normal, and fat is still embedded below the heel, the muscles are still intact, though considerably degenerated. The granules previously noted are for the most part not over 1 millimeter in diameter and are of a yellow color. They are relatively scanty. Some mulberry-like aggregations of these granules not over 2 millimeters in diameter are noted. They are not present in cavernous-like expansion of the sinuses.

C. Pathological histology. Blocks of tissue were removed for examination, including apparently unaffected skin overlying a group of sinuses, and similar blocks including nodules where sinuses were actively discharging material.

In studying the nodules one can distinctly make out two stages, (1) where the nodule is in process of formation but is not sinus crowned, and (2) where the nodule is sinus crowned. In the first situation the malpighian layer of the epidermis over the developing nodule, appears very much thinned out, and the papillæ are markedly atrophied. The nodule itself consists of a hyperplasia of young connective tissue with areas in which there is considerable infiltration with fibroblasts.

In the second instance the malpighian layer at the apex is very much thinned, while at the sinus opening it is entirely eroded and around the edges of the opening, is necrotic. At the periphery of the nodule there is considerable hyperplasia of the papillary, with the malpighian layer penetrating downward in thin finger-like prolongation. There is some round cell infiltration of the papillary layer. The center of the nodule is filled with a closely

packed accumulation of polymorphonuclear cells interspersed with a few lymphocytes. At the periphery loops of capillaries extend into the mass.

The subcutaneous tissue is increased in quantity and is undergoing very extensive hyaline degeneration. The sinuses either single or in groups are surrounded by particularly dense masses of connective tissue, and here and there are seen considerable aggregations of round cells.

The sinuses appear to lie in more or less parallel groups of two or three poorly distinguished or separate channels, cut across in various planes. Individual channels may be separated by a thin connective-tissue septa. Sinus channels vary considerably in apparent age. In apparently old channels no granules are visible, very few polymorphonuclear cells are seen and the lumen is filled with capillary loops, and an infiltration of fibroblasts. Where granules are present in the channel, the cellular exudate immediately about the granules is a dense infiltration of polymorphonuclear leucocytes; but along the walls of the sinus, round cells blend with the polymorphonuclears, and repair is evident by the formation of capillary loops.

Round or oval giant cells with smooth margins and containing 20 to 50 or more evenly distributed or peripherally situated nuclei are sparingly present in the cellular infiltration of the sinus channel. They are not seen in close proximity to the granules. Their cytoplasm is quite dense. No pigment is seen in the tissue.

Plasma cells are seen in the sinuses undergoing repair. No round cell infiltration of blood vessel walls is noted.

Scattered irregularly throughout the tissues lying either within the sinus channels in the fibrous walls of the sinuses, or in the hypertrophied connective tissue at a distance and with or without small red-cell accumulation about them, are numerous aggregations of spherical gram-positive bodies varying in size from 1 to 8 microns in diameter. For the most part any great like mass is composed of bodies of the same size usually from 4 to 5 microns. Usually the groups of this size have associated with them smaller bodies about 1 micron in diameter.

Fig. 6. Amputated foot.

The granules lying within the sinuses are apparently homogeneous staining (with eosin) slightly more intensely at the periphery than at the center. Hæmatoxylin, or gentian violet, does not stain any element within. In the peripheral zone of more intense staining there is a suggestion of radial striation. Smears of granules likewise fail to reveal any evidence of mycelian filaments.

I wish to express my indebtedness to Dr. Mark F. Boyd for his pathological report on this case, and to Dr. Violet Keiller and Dr. G. C. Lechenger for their photographic work.

DEPARTMENT OF TECHNIQUE

TREATMENT OF FRACTURE OF THE NECK OF THE FEMUR

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IT is universally conceded that fracture of the neck of the femur is a serious surgical condition. A large majority of the cases occur at an age when prolonged confinement to bed and sudden interruption of habitual activities are badly borne. Not a few of the patients are alcoholics and quite frequently, especially in this class, the injury occurs under such circumstances that the patient undergoes prolonged exposure to inclement weather. It is small wonder, therefore, that a considerable mortality attends this injury. In the cases which are not fatal, non-union or mal-union is almost invariable. This is due to the poor blood supply to the proximal fragment, and also to the fact that a large proportion of these fractures are impacted, and the surgeon, following traditional teaching, fears to disturb the impaction lest the last state of his patient should be worse than the first.

In view of these generally admitted facts it would seem desirable that each surgeon should set down clearly some general rules which will reduce the management of these difficult cases to something approaching a safe and rational routine. The purpose of this paper is to present the conclusions the writer has arrived at for his personal guidance as a result of his own experience.

As seen in practice, fractures of the neck of the femur fall more or less naturally into several groups. In the first group are patients of advanced age and general feebleness whose resisting power is at a low ebb. The heart is weak; circulation is poor. Sudden confinement to bed is irksome. The liability to hypostatic congestion constitutes an ever present danger. Under such circumstances we instinctively recognize the necessity of treating the patient rather than the fracture. Treatment resolves itself largely into good nursing, and efforts to make the patient as comfortable as possible. We support the fractured limb in an easy position by carefully adjusted pillows and sandbags. We endeavor to ward off lung complications by elevation of the head of the bedstead, and by frequently changing the patient's position. We do not hesitate to prop the patient up in the sitting position, and even to get him out of bed, as soon as this can be done without too much discomfort. Detailed care in regard to cheerful surroundings, to food, laxatives, stimulants, and the relief of pain should all be included in the management of the case. We do not expect a good functional result; should the patient survive, the future use of crutches is accepted as practically inevitable.

The second group is made up of patients sufficiently vigorous to rally quickly from the first shock of the accident and who do not appear to be threatened by the complications which menace the patients of the first group. This second group also includes most cases of impacted fracture, as well as those of epiphyseal separation and fracture of the neck of the femur occurring in early life; the same general line of treatment is applicable to all of them. Here the surgeon's responsibility is of a different order; it is his duty to make a conscientious and determined effort to secure for his patient such a functional result as shall prevent future disability or discomfort. Without attempting to review and compare the relative merits of the various methods by which the desired end may be sought, it is my personal opinion that the abduction treatment introduced by Whitman will give a larger percentage of good results than any other. It is not sufficient, however, merely to place the affected limb in the abducted position and retain it there in plaster of Paris for a given number of weeks; such a perfunctory performance only discredits the method and brings sure disappointment to both patient and surgeon. Unless the surgeon has a clear understanding how to proceed and is prepared to carry out the treatment systematically and with careful attention to every detail, he had better employ some more conventional method, otherwise he is almost certain to fail of reaching the desired goal for the simple reason that he has been following a false trail. In an emergency a suitable sacral support screwed to the end of a table, with a suitcase, or box of similar size and

shape to support the patient's shoulders, and a perineal post or a roller towel passed between the thighs for counterpressure, can be made to answer every purpose; but a special orthopedic table of the Hawley pattern is so much superior and more convenient that it should always be employed in hospital practice.

The patient is first clothed in either a combination suit or long stockinette drawers extending from the nipples to the toes. His back is protected by a heavy felt pad about 10 inches wide and 18 inches long, stitched to the stockinette so as to extend from the lower part of the sacrum to the mid-thoracic region. The patient, anæsthetized, is arranged upon the table with the lower part of the back resting on the sacral support, and the counterpressure post, padded with a towel, pressing against the pubes and perineum. Sufficiently strong manual traction is then applied to both limbs by assistants to equalize the length of the limbs, the surgeon at the same time lifting and pressing upon the trochanter so as to guide it to its normal position. As soon as measurements show the limbs to be of equal length while the pelvis is level, any remaining outward rotation is corrected by grasping the foot and rotating the limb until the patella points slightly inward, but the traction must not be relaxed while this maneuver is being carried out. Still maintaining the traction the limbs are simultaneously abducted to the extreme limit. If a final examination shows the pelvis level, the limbs of equal length, and the angle of abduction the same on both sides, the limbs and trunk are quickly bandaged with rolls of sheet wadding and a plaster spica applied extending from the nipples to the toes. Additional security of fixation is afforded by the plan of extending the plaster a short distance down the sound thigh; but if full abduction of both limbs is maintained while the plaster is being applied, and if the plaster is carried sufficiently high on the trunk, it is quite safe to leave the other thigh free, and, after hardening has taken place, to trim the plaster in such a way that there is no obstacle to flexion of the sound hip.

Care should be taken to place the foot at right angles to the leg, and the knee will be more comfortable if allowed to flex a few degrees while the plaster is hardening. The efficiency of the dressing will not be diminished if a window of considerable size is cut out over the abdomen, and this will add materially to the patient's comfort by permitting freer breathing. Another window should be cut out over front of knee to allow daily passive movement of the patella.

If the plaster has been properly applied the patient will not find it at all intolerable, and his position in bed can be changed as freely and as frequently as he desires without any danger of disturbing the fracture.

The dressing should remain undisturbed for 3 months; after being removed massage, passive movements, and functional muscle training will materially assist recovery and should be carried out daily for a number of weeks. Direct weight-bearing should never be permitted in adult patients inside of 6 months, and usually should be prohibited for a longer time. The process of repair can be judged to some extent by repeated X-ray pictures, but too great reliance must not be placed on radiographic appearances, experience having shown that union which in the picture looks to be perfectly sound may yield under the influence of the body weight. Freedom from discomfort during passive manipulation, and restoration of voluntary muscular control, afford much more reliable information as to the firmness of the repair. In most cases it will be safer to provide the patient with a caliper splint so adjusted that the bulk of the weight will be transmitted directly to the pelvis instead of coming upon the recently fractured neck of the femur; this splint should be applied before weight-bearing is permitted and be worn for several months.

I have purposely avoided using the term "intracapsular" and "extracapsular," for they have little or no practical bearing on the subject under discussion.

The term "impacted" cannot, however, be dismissed quite so summarily. There are cases where nothing but a slight crumpling or telescoping of the neck of the femur has occurred. The shortening is insignificant; there is a very slight degree of outward rotation and only moderate discomfort or functional disability. Massage should be used from the first and a short period of confinement to bed, followed by the use of crutches, a caliper splint, or even only a stout stick, will complete the treatment. A good functional recovery with only slight lameness and some limitation of movement will be the ultimate outcome.

The severer degrees of impaction should be treated by the abduction method just as if the impaction did not exist; indeed, it is by no means always as easy to determine whether the fracture is impacted or free, as the textbook descriptions would lead one to suppose.

The functional recovery in bad cases of impaction is rarely satisfactory. The limb is short and

and may remain more or less painful indefinitely. There is sure to be some permanent restriction of movement. It is much better to disimpact, and this is accomplished by the same series of manipulations as are employed when the fracture is known not to be impacted, the limb being then put up in the abducted position as already described. The average ultimate result is certain to be more satisfactory than if the surgeon allows himself to be misled into inactivity by fear that disimpaction may result in non-union. As a matter of fact disimpaction in these cases rarely, if ever, means that contact of the fragments with one another is interrupted. The changed relation is comparable to that which occurs when a green-stick fracture is carefully straightened; consequently, while the deformity is corrected the probability of bony union occurring is not unfavorably influenced if the contact of the fragments is maintained by efficient abduction treatment. The ease with which disimpaction can be accomplished by the same series of manipulations that we use in cases which are not impacted, affords convincing evidence that impaction does not always mean that firm locking together of fragments which constitutes the traditional conception of this condition.

As Whitman first pointed out, fracture of the neck of the femur and epiphyseal separation are by no means uncommon in childhood and adolescence. In these cases the abduction treatment, properly carried out, will nearly always yield excellent functional results and in less time than is required for older patients.

There remains to be considered the group of cases which we encounter weeks, months, or even years after the original injury, the patient complaining of varying degrees of discomfort and disability. At one extreme is the patient who suffers nothing more than slight lameness and moderate discomfort after over-exertion, but who is unable to understand why he should not be entirely well and comfortable if he had been properly treated at the beginning. Most of these patients can be dismissed without treatment and will go away satisfied after it has been carefully explained that a perfect recovery after such a serious injury as fracture of the neck of the femur is very exceptional, that they must be thankful for being disabled to only a small extent, and must philosophically adjust their activities to the fact that the injured limb can never again be one hundred per cent efficient. At the other extreme is the patient who is unable to walk without crutches and who suffers more or less constant discomfort, and sometimes actual pain, and is in consequence forced to abandon most of customary activities.

While the patients in this group present problems which may be more or less individual in certain details, roughly speaking they will be found to separate into two subgroups: those who should be submitted to operation and those who should not. If the patient be very advanced in years, in poor general health or greatly enfeebled from any cause, we must be content with efforts to make him more comfortable by the use of radiant heat, massage, gentle passive movements and exercises. He must also be provided with a comfortable shoe with sufficient cork elevation to compensate for shortening; this will prevent the additional discomfort which results from tilting the pelvis at a time of life when the lumbar spine has lost much of its earlier flexibility. Further, the wise surgeon will not neglect the patient's mental attitude, and can often do much good by cultivating in him a spirit of cheerful acceptance of his physical limitations. But if careful examination shows the patient to be free from organic disease and in possession of a fair degree of resisting power, relief should be attempted by operation. What shall this operation be?

It will not be disputed that a relatively simple operation from which the patient will recover in a few weeks, which can be quickly performed with little shock and with a minimum loss of blood, which will not prevent the patient from being moved freely in bed in the after-treatment, and which is reasonably certain to afford a fairly good ultimate functional result, has distinct advantages over more complicated procedures which entail greater traumatism, more immediate danger, and a longer period of convalescence. Such an operation is found in complete removal of the head and neck of the femur, followed by implantation of the trochanter in the acetabulum.

I am not a stranger to other methods of operation. I have tried opening up the region anteriorly and directly adjusting the fragments after freshening the fractured surfaces. This is not a difficult operation, but it has few advantages over the abduction treatment without operation and requires quite as prolonged a period of convalescence and after-care as the latter.

I have had no personal experience with Brackett's method of attempting to bring about union between the head and the trochanter, but I have on several occasions successfully pinned the fragments together with a bone-graft. My opinion is that such operations are much more difficult and attended by greater risk; they require

a much longer period of convalescence and will not give better average functional results than the simpler operation herewith advocated.

The operation is performed as follows: Gas-oxygen anæsthesia preferred; patient supported partly on the sound side by large sandbags. Kocher incision about 8 inches long extending about 4 inches upward and backward from the top of the trochanter in the direction of the fibers of the gluteus maximus and downward along the outer side of the femur for about the same distance. This incision should be clean and rapid. The first cut will usually expose the gluteus maximus above and the fascia lata below. By incising the fascia lata in the line of the lower arm of the incision the attachment of the gluteus medius is fully exposed. In that part of the incision above the trochanter the fibers of the gluteus maximus can be separated with very little use of the knife, or, better still, the upper border of the muscle is defined and retracted backward. An incision carried to the bone is then made along the line of insertion of the gluteus medius, extending from the anterior border of the trochanter upward and backward to the upper angle of the trochanter posteriorly. The whole upper end of the trochanter is then quickly cleared, either by dissecting close to the bone with a sharp knife, leaving only the periosteum, or by detaching the periosteum itself with a chisel and mallet, leaving the bone bare. I have come to prefer the former method because it is better to have the trochanter, which comes into contact with the cartilage of the acetabulum, covered with soft tissue, as a precaution against ankylosis. Keeping close to the bone and working from behind forward and upward the gluteus medius is detached. From the anterior face of the trochanter the gluteus minimus is severed; working backward along the summit of the bone the pyriformis, and behind it the obturator internus with the two gemelli are set free, and dipping down on the inner aspect the obturator externus is liberated from the digital fossa. The description seems lengthy, but the maneuver can be executed in one continuous rapid movement.

Having cleared the trochanter and exposed the capsule, this structure is split along the axis of the neck and separated from its attachment by a circular incision, the assistant meanwhile rotating the limb inward or outward, as directed, so as to provide access to all aspects of the outer part of the neck. If not already separated the base of the neck is divided from the trochanter with a wide osteotome, and the thigh being flexed, adducted, and rotated inward by an assistant, the inner aspect of the femur can be quickly smoothed as low as the upper border of the lesser trochanter. In most cases this should be done before any attempt is made to remove the head from the acetabulum as more room is thus obtained. In old cases with fibrous union the forced flexion, adduction, and inward rotation may dislocate the head more or less completely, but when the head is completely detached and remains like a ball in the socket it can be removed by using a wide Jones gouge as a lever; should there be any difficulty the head may be split with a chisel into two or more fragments which are then removed by lever and lion-jaw forceps. By abduction of the limb and direct pressure the trochanter is then easily guided deeply into the acetabulum, and this abducted position must be steadily maintained until the plaster dressing has been applied. With a large curved needle and a continuous stout catgut suture the separated muscles are drawn together and stitched to the outer aspect of the trochanter. The fascia is also repaired with catgut and the skin brought together with silkworm gut. Over abundant padding, special attention being given to the comfortable protection of the sacrum and spine, a plaster spica is then applied from the nipples to the toes, the thigh being kept fully abducted and, as in the cases which are not submitted to operation, the dressing will be more comfortable if the knee is kept slightly flexed. The foot should, of course, be placed at a right angle to the leg. This dressing need not be disturbed for 5 or 6 weeks, and in the meantime no harm will result from moving the patient about in bed with any desired frequency. It is impossible to disturb the wound or change the position of the femur to any harmful extent if the patient be turned partly or wholly on the side, or even on the face. While wearing the plaster the patient can be taught to exercise the quadriceps, and in fact nearly all groups of muscles in the leg and thigh, by trying to make the movements which bring the various groups into play. These efforts will do much to preserve muscular tone and diminish the tendency to atrophy. This kind of muscular exercise should be encouraged, not merely in cases which are operated upon, but in all patients in whom the abduction treatment in plaster of Paris is carried out. Having removed the plaster at the end of 5 or 6 weeks, massage and gentle manipulation should be commenced; while movement will at first be more or less painful, usually it is not more than a fortnight before the patient can be got out of bed.

Standing on the feet, supported on either side, then the use of crutches, and finally the sub-

stitution of a stick for the crutches, follow in natural sequence. Ultimately it may be possible to dispense with even a walking stick. A fair degree of movement is regained, and in the end there is little discomfort and only a trifling amount of shortening.

It must not be supposed that the trochanter always remains deeply implanted in the acetabulum; indeed an X-ray picture taken a few months after the operation may in some cases alarm the uninitiated by giving the impression of impending dislocation, or at least mechanical insecurity. A moment's consideration of the anatomical conformation of the parts will show that as abduction is reduced the top of the trochanter tends to travel outward on the roof of the acetabulum, and with the extremity brought to the vertical position the X-ray may show the top of the trochanter resting somewhere about the upper part of the rim of the acetabulum; but development of sufficient strong fibrous tissue has taken place in the meantime to provide secure anchorage and there is no upward riding when weight is borne on the limb.

While the description of the operation is apt to convey the impression that it is difficult and complicated, it is possible, after one has acquired familiarity with it, to carry it out with considerable speed, a factor of great importance in patients who are aged or not very vigorous. The skin should be prepared and the draping of the patient with sterile sheets and towels completed before the anæsthetic is administered. It is quite possible to have the trochanter in the acetabulum and closure of the wound begun in 8 or 10 minutes from the time of making the first incision, and with good assistance the plaster should be in place and the patient ready to be returned to bed in not more than three-quarters of an hour from the time the operation was commenced; in one of my recent patients, a lady 74 years, this was accomplished in 34 minutes (Case 6). The loss of blood is usually trifling. I have performed the operation without tying a single vessel, but usually two or three ligatures are necessary. Even in patients of advanced age there is often no evidence of shock.

My confidence in this operation, as applied to fracture of the neck of the femur, grew out of a fairly large experience with the good functional result following removal of the head and neck and implantation of the trochanter in the acetabulum in cases of osteo-arthritis and tuberculosis of the hip, in bad cases of coxa vara, and in selected cases of congenital dislocation where the patient had reached an age when reduction without removal of the head was impossible. In fact, the functional result in most cases following the operation, for whatsoever reason performed, is usually so good that in my opinion its application to fracture of the neck of the femur might be extended much more widely than I am advocating in this paper. If, by an operation which is attended by little risk, the patient can be given a limb that functionally is as good as, or better than, that which can be secured by the best conservative treatment, and if this result can be achieved in half the time, there does not seem any reason why the operative method should not become more or less a matter of routine in the hands of skilled surgeons. At any rate my personal confidence has reached the point where I am prepared to extend the scope of this operation very considerably, as I am persuaded it might well be applied to a large proportion of the cases usually treated by the Whitman abduction method. Brief reports of six cases treated by this operation will now be given.

CASE 1. Mrs. J., age 55. Four months before she came for advice, patient had fallen and "sprained" her right hip. She did not have any medical treatment. Patient was unable to walk without crutches; X-ray showed the head of the femur to be detached. Operation May 20, 1919, when the head was removed and the trochanter placed in the acetabulum as described. Patient made uneventful recovery; plaster was removed in 6 weeks and patient encouraged to move limb. Movements were at first uncomfortable, but the discomfort soon largely subsided and within a few weeks patient was able to walk with reasonable freedom. The final note of this patient's history sheet bears date February 17, 1920, and reads: "Examined today. Result is entirely satisfactory; she limps a little and has about three-quarters of an inch of shortening but there is good movement in abduction and adduction, and about 60° of flexion. She suffers very little discomfort."

CASE 2. J. M., male. Gave his age as 63 but looked like a man 10 years older. His arteries were hard and calcified. He also had an enlarged prostate and a double inguinal hernia. Three weeks before I saw him he had severely injured his right hip. The patient was suffering so much pain that a satisfactory examination was impossible. He could not lie down with any comfort nor allow the limb to be straightened. It was necessary to administer an anæsthetic before an X-ray picture could be taken. The picture showed fracture of the neck of the femur. Operation in this instance was not an inviting proposition but something had to be done to relieve his suffering, and I decided that operation would probably be less dangerous than any other course. It would have been impossible to apply adhesive straps for extension without an anæsthetic, and I felt satisfied the patient would not tolerate the extension after it had been applied; and the abduction treatment without operation meant a too prolonged period of invalidism. Operation October 4, 1919. The head and neck were excised and trochanter placed in the acetabulum; limb was widely abducted in plaster. Practically from the first hour patient was comfortable. He was very thin, and unfortunately, while still in the plaster, developed a bad bedsore in the dorsal region which took

a long time to heal. The plaster was removed in 6 weeks. Patient was feeble, bladder and bowels gave trouble; the double rupture did not add to his comfort and he suffered additional disadvantage from his bedsore; but notwithstanding all these drawbacks, he was soon sitting up part of the time and was removed from the hospital to his home 2 months after the operation. Functional recovery was very slow. Two months later, while free from pain, he was unable to move about without leaning on a chair. Patient's general feebleness was largely responsible for his slow recovery. This was an extreme case but illustrates that the operation itself need not place the patient in danger. I last saw this patient on May 11, 1920, 7 months and 1 week from the time of his operation. He could walk without any aid whatever, but used a crutch and stick as he was unsteady and feared that he might fall. He was comfortable and could flex the thigh sufficiently to permit him to sit upright in an ordinary chair. He was constantly gaining, and it was quite evident that further functional improvement would occur as time passed.

CASE 3. Mrs. K., age 68, suffered a fracture of neck of right femur 7 months before I saw her. She suffered a great deal of pain and was unable to bear much weight on the limb. She did not use crutches and moved about very little and only by pushing a chair before her. She also had fibrous ankylosis of the right knee, permitting only 20° of flexion. X-ray showed fracture with non-union, the trochanter being high above the head. Operation October 23, 1919; the head and neck were removed and the trochanter implanted in the acetabulum. After the first few days the patient was very comfortable. Plaster cast was removed in 6 weeks. Radiant heat and massage treatment was commenced at once, and patient encouraged to get out of bed daily. In 4 weeks she was able to get about the room freely and comfortably with the aid of a chair. Recovery in this case was hampered by the accompanying partial ankylosis of the knee. She was last examined on May 7, 1920. She was very comfortable and constantly improving; she walked well with the aid of a walking stick which she used chiefly because it gave her a sense of greater security.

CASE 4. Mrs. M., age 40, was first seen on February 28, 1918. Patient said she had injured the upper part of her left thigh 5 weeks before she consulted me. She did not think her hip had been injured. She had never been able to walk since her accident but could move about the room assisted by a crutch and another person supporting her. Examination showed the limb an inch and a half short, the foot rotated outward and the trochanter much above the normal level. X-ray showed fracture of neck of femur. Operation on March 4, 1918. The fracture was exposed through an anterior incision and the head found completely separated from the neck and loose in the acetabulum. The fragments were freshened and manipulated as far as possible into normal relationship. Through an external incision an awl was inserted through the great trochanter and neck up to the head so as to gain exact information regarding the direction to be followed by the large electrically driven drill by which a suitable tunnel was created through the trochanter and neck; a bone-graft was then driven through this tunnel so as to pin head and neck together. A plaster spica was worn until June 11, 1918. Six weeks later the patient was walking well with only a stick. On December 9, it was noted that her condition was very satisfactory, there being but little lameness and only a trifling amount of shortening. Patient did not report again for 6 months. She called at my office on March 2, 1919, for examination, stating that she thought the limb was becoming shorter and had been less comfortable for a number of weeks. Examination revealed shortening of an inch and a quarter, and X-ray showed that the neck of the bone had given way and had been partially absorbed. As patient's general health was unsatisfactory at this time she was referred to Dr. Burridge who, in the course of a systematic investigation of the case discovered that she had a 3+ Wassermann, and he placed her under appropriate anti-syphilitic treatment for a number of months. I examined her again on December 4, 1919. There was a great deal of lameness and considerable pain; she used a stick all the time. A stereoscopic X-ray picture showed the head behind the trochanter where it was evidently serving no useful purpose. On December 30, I excised the head and the remainder of the neck and placed the trochanter in the acetabulum. The limb was dressed in plaster in wide abduction in the usual manner. Plaster was removed on February 7, and patient left the hospital a few days later. On February 24 (a little less than two months after her operation), she came to my office on crutches. The limb was comfortable and she would walk across the room without even a stick. She continued to improve steadily and in another month was walking well, but when going any distance she still used a stick. X-ray picture showed the head resting near the rim of the acetabulum, but there was perfect mechanical security.

CASE 5. Mrs. J., age 74. Severe fracture of neck of femur 2 weeks before I first saw her. Patient was well preserved for her age. Operation was advised and was carried out on April 30, 1920. Patient was fully prepared before the anæsthetic was started. Gas-oxygen anæsthesia was administered by Dr. Webster. Head and neck removed in the usual way and trochanter smoothed off and placed in acetabulum. In 34 minutes from the time the incision was commenced the plaster dressing was in place and the patient ready to be returned to the ward. At no time did she have the slightest evidence of shock, and recovery proceeded uneventfully. Patient left the hospital for her home 12 days after the operation.

CASE 6. Mrs. McD., age 50, first consulted me on May 19, 1920. Eight years before I saw her she developed left hemiplegia which left her with a useless arm, but she was able to get about actively until August, 1919, when a large dog ran against her and knocked her over, since which time she had never been able to walk at all. The limb was short and everted and movements considerably restricted. There was also marked contracture of the tendo achillis making it impossible to bring the foot to a right angle with the leg. X-ray picture showed fracture of the neck of the femur. Practically all of the neck had been absorbed and the trochanter was on a considerably higher level than the head. Operation on May 26, through Kocher incision, the remaining fragment of the neck was removed leaving the inner aspect of the trochanter smooth. The head was then taken away and the trochanter implanted in the acetabulum with the limb moderately abducted. The wound was closed and the plaster spica completed in 40 minutes from the commencement of the operation. Patient was a large fleshy woman so that the wound was very deep and the operation more difficult than usual. Gas-oxygen anæsthetic was used. There was absolutely no evidence of shock. The patient withstood the operation well and has done uninterruptedly well since but the operation was performed too recently to make possible any opinion as to the ultimate functional result.

POSTEROLATERAL INCISION FOR THE REMOVAL OF LOOSE BODIES FROM THE POSTERIOR COMPARTMENT OF THE KNEE-JOINT

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LOOSE bodies are not infrequently present in the posterior compartment of the knee-joint. Occasionally they may wander into the anterior compartment and be readily accessible, but more often they are too large for this and it is necessary to remove them through an incision that will permit access to the posterior compartment of the joint. Brackett and Osgood[1] in 1911 described an incision through the popliteal space which is excellent but entails careful dissection in order to avoid the popliteal vessels and nerves, and it is difficult to make particularly in fleshy or muscular patients.

The posterior compartment of the knee-joint is practically divided by a mesial septum into internal posterior and external posterior compartments. A posterolateral incision is therefore often necessary on both sides, in order that the exploration for the bodies may be completed, but both incisions are small and practically no dissection is needed.

The knee is prepared in the usual manner and a tourniquet applied. The foot of the table is not dropped as in explorations for semilunar cartilages, or in splitting the patella. The knee is flexed to a right angle, thus relaxing its posterior capsule. If the loose bodies are all in the outer division of the posterior compartment the incision should be made posteriorly, well on the outer side but in front of the fibula (Fig. 1). A semilunar incision with the convexity anteriorly or posteriorly may be made in the skin, and a straight incision parallel with the longitudinal axis of the leg made in the capsule. This may be enlarged and retractors placed to give an excellent view of the posterior cavity of the joint. A large curette or gall-stone scoop may be used to explore and remove the loose bodies. The mesial septum

[1] Brackett, E. G., and Osgood, R. B. The popliteal incision for the removal of "joint mice" in the posterior capsule of the knee-joint. A report of cases. Boston M. & S. J., 1911, clxv, 975–976.

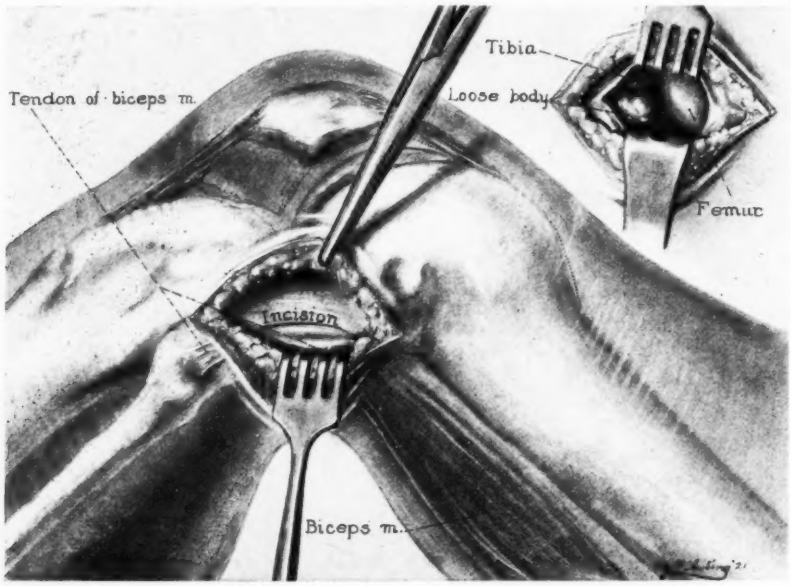

Fig. 1. External posterolateral incision. Insert shows loose body.

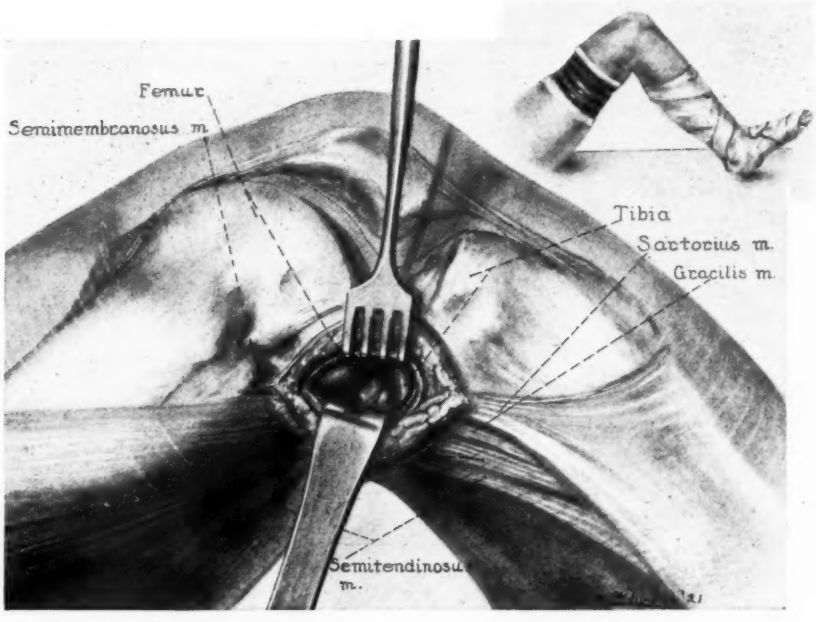

Fig. 2. Internal posterior lateral incision. Insert shows knee flexed to the right angle, and the position of the leg on the operating table.

prevents ready access to the inner compartment, and if exploration on that side is necessary, rather than to cause trauma to the interior of the joint by forcing an instrument through it, an incision similar to the one just described should be made on the inner side. This is anterior to the relaxed tendons of the semitendinosus, semimembranosus, cartorius, and gracilis muscles (Fig. 2), and gives ready access to the inner division of the posterior compartment. Plain catgut sutures are used to close the capsule and silkworm and dermal sutures to close the skin. Fixation in plaster of Paris or by splint is not necessary although it may be employed for 24 to 48 hours to prevent bleeding that may follow involuntary movements of patient on coming out of anæsthetic.

TREATMENT OF CARIES OF THE HIP-JOINT AND SOME OBSERVATIONS UPON THE USE OF A TRACTION ABDUCTION SPLINT

By EDWARD H. BRADFORD, M.D., F.A.C.S., Boston
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THE treatment of hip disease is a highly desirable surgical achievement as the affection is not uncommon and is a formidable one. It appears, however, that the best method of treating this affection has not been generally employed, if it be possible to judge from the cases brought to the Massachusetts Hospital School from the different parts of the state. A reason for this is to be found in the fact that few cases are treated from start to finish by the same doctor. As a result, the methods of treatment used are of the nature of temporary experiments rather than parts of a consistent plan. The records of the Massachusetts State institution which are full and comprise histories of approximately two hundred cases during several years of close observation, show that patients suffering from undoubted hip disease, consistently treated, may be absolutely and permanently cured in a large number of cases and that the consequences of faulty methods are lamentable. In untreated hip disease, nature never cures without deformity, while in properly managed cases deformity does not occur. Not only is the mortality much lower in well treated cases than under partial treatment, but also the functional result after proper treatment is incomparably superior. In the cases which form a basis of this statement, there can be no reasonable doubt of the correctness of the diagnosis, as no case was recorded as one of hip disease which was not examined by a number of experienced observers with the aid, in many cases, of roentgenogram and reaction tests, as well as a careful examination of previous histories. The term "hip disease" is used as defining a chronic carious process attacking the bones of the hip-joint. No attempt is made to classify according to the localization of the original focus or to the character of the invading germ, that is, bovine or human tuberculosis, or as to mixed or pus-making bacilli. One case is presented as illustrative.

CASE 1. (Figures 1, 2, and 3.) Patient previously treated with plaster spica. He had pain, spasm, slight

Figs. 1, 2, and 3. Case 1. Photographs taken 2 years after discharge from hospital.

Fig. 4. Plaster-of-Paris spica.

Fig. 5. Plaster-of-Paris spica.

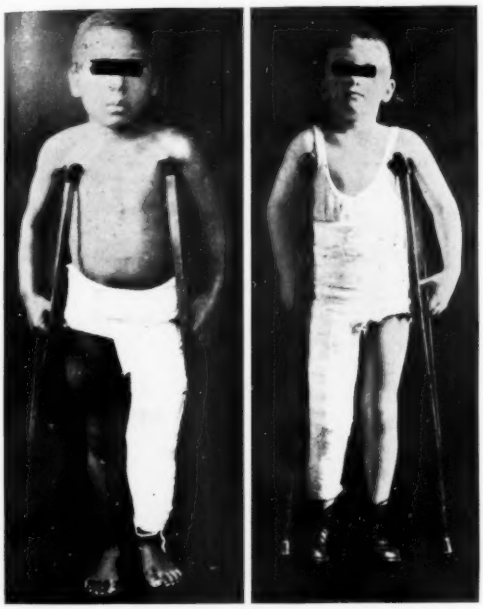


Fig. 6. Short plaster spica bandage.
Fig. 7. Long plaster spica bandage.

motion, and 40° flexion on admission. Duration of disease 1 year. After admission he was treated with traction abduction splint, high sole, and crutches for 3 years. Pictures were taken 2 years after discharged. Patient has full motion and no shortening.

Judging from the clinical histories of many of the cases brought to the Hospital School, mistakes were made in failing to recognize the disease at an early stage. The invasion is usually insidious and both the parents and the doctor hesitate to condemn a child on slight evidence to the rigors of strict treatment. An X-ray print shows no bone destruction at the earliest stage, little progress having as yet been made by the disease.

A temporizing policy is too often adopted, to the great detriment of the joint. A definite diagnosis is not difficult, even at an early stage, certain symptoms being almost pathognomonic. A persistent limp, however slight, combined with limited passive and active motion in all directions at the hip-joint means threatened carious destruction of the joint and the need of carefully protecting it from any injurious pressure or trauma.

Nature cures a carious hip by flexing and adducting the thigh through muscular contraction of the periarticular hip muscles. This guards the joint from injurious jar. If the carious process is extensive and both the femoral head and the acetabulum are involved, the natural cure is accomplished by the exaggerated pressure of the femoral head crowded against the upper and posterior part of the socket through the excessive contraction of the joint muscles. This increased pressure increases the bone destruction of the

Fig. 8. Case 2.

Fig. 9. Case 2.

Fig. 10. Case 3.

Fig. 11. Roentgenogram taken 22 years after subtrochanteric osteotomy.

femoral head and eventually a subluxation takes place. Pressure being in this way relieved between the carious bone structures, the diseased bone tends to heal unless later septic complications incident to the discharge of carious detritus abscess formation, sinus and mixed infection, destroy the patient's life.

The purpose of the surgical art is to aid nature's cure and this is accomplished by checking joint bone crowding. Constantly bruised bone tissue is slow in healing and the surgeon should seek to favor recovery by protecting the epiphyseal ends from this form of injury.

Judging from a considerable number of cases subjected to plaster-of-Paris spica bandage treatment, the surgical indications are not fully met by this form of restraint (Figures 4 and 5). The chief defect of the plaster spica method is that it fails to furnish either adequate fixation or to counteract upward hip bone crowding by the contracting hip muscles. It may serve as a temporary aid in transporting a patient with a sensitive hip; but it is readily seen that it is next to impossible to apply a plaster bandage which if long continued does not become burdensome to the patient. Soft tissue and bone atrophy, as well as an unhealthy condition of the skin, necessarily follow. The patient's general condition suffers as he finds himself uncomfortably walled about in a stiff plaster case.

As success in the treatment of bone tuberculosis depends to a considerable extent upon the patient's condition, the continued use of a long plaster spica bandage cannot be recommended, while to be content with a short spica is to be satisfied in hip caries with inadequacy (Figures 6 and 7).

Satisfactory results have been obtained at the Massachusetts Hospital School by the employment of an abducting extension splint which had previously been proved to be of service at the Children's Hospital in Boston. Other forms of traction splint used elsewhere have not proved as satisfactory as the one here mentioned. The simpler form is more readily manufactured, more easily applied, and without perineal straps furnishes better fixation, as well as abducting traction.

The splint should not be applied until extreme flexion or adduction deformity is corrected, and although it is intended to be used as an ambulatory apparatus and can be so employed even in acute cases, the additional precaution of crutches is advisable except in the convalescent stage when the splint can serve as a perineal crutch, discontinuing the traction straps. Traction having been removed, the appliance has an important advantage in furnishing proper opposition to adductor contraction. The continued use of the splint is indicated as long as muscular spasm is present. Traction can be gradually diminished as spasm subsides. The apparatus can be worn at night or traction with bed frame fixation can be substituted.

The effectiveness of the abducting traction splint in fixing the hip and in counteracting injurious muscular force is illustrated in its usefulness in the treatment of fractures of the femoral neck.[1] Success in the treatment of hip disease necessarily depends upon the condition of the tissues when thorough treatment is begun. Much benefit can be hoped for even in advanced cases, as is seen from the following case histories.

CASE 2. (Figures 8 and 9.) A 13 year old Jewish boy suffered from tuberculous disease of the hip-joint previously treated before admission with plaster spicas. After

[1] New York M. J.. 1919, Nov. 22, 835.

admission he was treated with traction abduction splint, high sole, and crutches. About a year later sinuses appeared with marked destruction of tissue followed by development of amyloid disease. Seven years after admission there was a gradual improvement with cessation of sinuses and receding of liver's edge. Two years later traction was discontinued and splint removed the following year. At present patient is working every day.

CASE 3. (Fig. 10.) A bright, 13 year old girl had double hip disease of a year's duration. Examination on admission showed motion in flexion 45°, abduction 30°, and adduction 30° in both hips: no rotation; muscular spasm present; both legs equal length; moderate amount of trochanteric thickening; many healed sinuses; hyperextension limited; treated with traction abduction splints, high sole, and crutches for nearly 2 years, followed by convalescent splint for 1 year. Discharged 8 months later recovered, to attend high school.

When the carious process is healed with marked deformity and bony ankylosis, splint treatment is evidently of no benefit. This condition is not common in young children and none is reported in the series here considered. The best method of meeting this condition is by subtrochanteric osteotomy, correcting the flexion and placing the limb in an abducted position in order to give the tilted pelvis a practical increase of the length. The accompanying X-ray (Fig. 11) is of interest as showing a result taken 22 years after a subtrochanteric osteotomy for the correction of an ankylosed right angle flexion with adduction following hip disease. The patient has been engaged since operation in an active occupation for 20 years, walking with no apparent shortening and with scarcely perceptible limp.

In desperate cases in which the acetabulum is seriously involved, a method can be employed which, judging from the experience of the few cases in which it has been applied, deserves more general consideration than it has yet received. A free posterior incision is made down to the joint, the head is forcibly pulled out of the socket, and the limb held in a flexed and adducted position by a plaster anterior splint, freeing the diseased acetabulum from bone pressure by forcibly dislocating the hip and draining the acetabulum thoroughly by free incision. Locomotion is soon possible with crutches, healing can be expected to take place as in the natural cure of hip disease, and the resulting deformity can later be corrected.

Anyone whose recollection goes back to the earliest methods of treatment and who compares the results then obtained with those observed at the Hospital School will be satisfied that progress has been made in an understanding of the nature of hip disease and of the principles which should govern treatment; but it also appears that plaster spica bandages do not give satisfaction as a method of treatment and should not be used except as an emergency and as a temporary measure.

A critical reader of the foregoing might hastily conclude that the most successful cases reported were not true cases of hip disease. He would, however, think differently if he had personally examined the patients and their clinical histories. Those most successfully treated were not selected and isolated examples but parts of a series including a comparatively large number of patients with similar characteristic syndromes carefully observed and recorded by well trained surgeons. The cases differed considerably in the amount of joint destruction which had taken place before entrance into the Hospital School and it was apparent that the more thorough the treatment in protecting the joint from injurious joint pressure, the better the ultimate functional result. If tuberculous foci of the lung and other tissue heal when favorable conditions are provided, the same can be expected to be true in bone. In the early stages of hip disease a germ-congested area in the epiphysis gives rise to joint symptoms before much change in the shape of the bone has occurred. If the morbid process is arrested in this stage, a complete functional recovery may be hoped for. The early acceptance of aseptic surgery was delayed, in many communities, by the skepticism of those who, having observed no benefit in the imperfect employment of improved methods, rejected their use. It is always easier to doubt than to form a judgment on thoughtfully studied facts. Ample evidence can be presented to those ready to examine facts demonstrating that caries of the hip-joint taken early and thoroughly treated is an affection which can be definitely cured with practical restoration of function.

EDITORIAL

SURGERY, GYNECOLOGY AND OBSTETRICS

FRANKLIN H. MARTIN, M.D. .....Managing Editor
ALLEN B. KANAVEL, M.D. .....Associate Editor

DECEMBER, 1921

CONTRIBUTIONS OF SURGERY TO OUR KNOWLEDGE OF THE PHYSIOLOGY AND PATHOLOGY OF THE SPLEEN

A SENIOR medical student, up for his final examination, was asked by the professor of physiology, "What is the function of the spleen?" After considerable hesitation and digital irritation of the scalp he replied that he had known but had forgotten. "What a pity," said the professor, "for you are the only man who has ever known."

One of the most remarkable features of splenic pathology concerns the fact that the spleen is an organ which has great pathological potentialities, but which appears to have no function of sufficient importance to be disturbed by its removal.

A side light on the function of the spleen is its direct association with the liver, shown by the fact that whatever the function of the spleen may be, it is unable to complete the work that it initiates. The blood from the spleen must pass through nature's great metabolic laboratory, the liver, before it enters the general circulation.

Experimental work on the spleen on the whole has been disappointing. Some facts of value have been brought out, but there has been a fairly general failure to correlate experimental work on healthy animals with the disease conditions of the spleen in man, although after carefully reviewing this experimental evidence one is perhaps in a little better position to guess than he was before. After all, more dependence is as yet to be placed on mass clinical evidence than on animal experimentation. Out of the confusion certain facts and near facts can be discerned which at least demonstrate that the principal function of the adult spleen is directly connected with the blood, hence its huge supply of blood out of all proportion to other organs of its size, except the kidney. It is apparent, too, that the effect of the spleen on the blood is of a three-fold nature.

1. The spleen destroys deteriorated red corpuscles. Some of the enlargements of the spleen, as in hæmolytic icterus, might be regarded as work hypertrophy, and splenectomy gives brilliant results. In pernicious anæmia the patient is unable to produce normal red cells, and it may be that the spleen acts deleteriously by the destruction of red blood-corpuscles which, while reduced in value, are capable of function and are the best the patient can generate. This may explain the value of splenectomy in pernicious anæmia. Perhaps akin to this is the effect of the spleen on the blood of the patient suffering from so-called splenic anæmia in which the red blood-corpuscles are unnecessarily destroyed by an overaction of this particular function of the spleen which in splenic anæmia is in some way associated with increased size, thrombophlebitis, generalized fibrosis, and atrophy of the

pulp cells. In these splenomegalias splenectomy has great value.

2. One of the most interesting functions of the spleen is its strainer action by which microorganisms are removed from the blood-stream and sent to the liver for destruction. If the spleen is unable to deliver these microorganisms to the liver splenomegalias develop, such as occur in typhoid, chronic syphilis, malaria, and tuberculosis.

3. The third function of the spleen is largely hypothetic and stands on much less reliable ground, depending on experimental evidence about which no two experimenters are well agreed, but it seems reasonable to assume that the spleen may originate hormones which act through the blood-stream on organs at a distance, especially on the bone-marrow.

Polycythæmia may be the result of splenic hormones in the blood, the overstimulated bone marrow producing red cells in excess so that the number sometimes reaches as high as 9,000,000 to 12,000,000 and the hæmoglobin more than 100 per cent. The patient with polycythæmia (rubra vera) often appears cyanotic. In one case of this rare disease I removed the greatly enlarged spleen with extraordinary improvement. One cannot safely draw conclusions from a single case, especially in the light of postmortem findings following death from this disease. Pathological conditions in the living, however, have demonstrated over and over again that some conditions found at necropsy may be terminal, and nonexistent in the earlier stages of the disease. The result in this case suggests at least that the spleen plays a greater part in polycythæmia than has been believed and that in some cases splenectomy may be indicated.

Medical tradition is responsible for the statement that the patient with splenomyelogenous leukæmia will not live following removal of the spleen and for the further paradoxical statement that splenectomy can do no good if the patient does recover. The patient will volunteer the information that any method of treatment which will reduce the size of the spleen improves the general condition, and that whenever the effect of such remedial measures has passed off the spleen again enlarges and the general condition becomes worse. Certainly the idea that the spleen cannot be removed successfully in splenomyelogenous leukæmia is incorrect. In twenty-seven splenectomies in our experience for which the patients were properly prepared by irradiation of the spleen there was but one death, and that from embolus 2 weeks after operation. While the improvement was temporary in most instances a few of the patients have had such extraordinary betterment, lasting such a length of time as to suggest that they were not truly leukæmic; this illustrates how little we know about the spleen.

Accumulating clinical evidence goes to show that chronic enlargements of the spleen are to be looked on as potentially surgical, although not necessarily operative, and that we must in the future depend on massed clinical facts as well as on experimental evidence to develop our knowledge of the physiology and pathology of the spleen, and not be misled by what our forefathers thought and rashly committed to print.

WILLIAM J. MAYO.

BOOK REVIEWS

A CRITIQUE OF NEW BOOKS IN SURGERY

THE problem of keeping medical textbooks up to date is undeniably a difficult one, and increases in direct ratio to the size and comprehensiveness of the work involved. When a treatise on medical practice attains the size of Keen's *Surgery*,[1] the task of re-editing and keeping it abreast of the times becomes truly formidable. Dr. Keen and Messrs. Saunders have met the problem by the publication of two new volumes, VII and VIII, to supplement the original edition of five volumes, and of the sixth volume published 8 years ago.

Simply to read the names of the contributors to Keen's *Surgery* is to feel oneself in the midst of a notable company. The editor fittingly says in his preface, "I count it the crowning privilege of a long life to have been associated with so distinguished a company of authors."

With a work so extensive in its scope, it is impossible in a brief review to do justice to each individual part. Volume VII contains a number of chapters which are concerned chiefly with military organization and purely military surgery, and which need only to be mentioned. The most important feature of the volume is the section on bone and joint surgery, divided into "Fractures" by Eisendrath and Straus, "Gunshot Fractures" by Blake, "Military Surgery of Joints" by Pool, "Orthopedic Surgery in Civil Life" by Lovett, and "Military Orthopedic Surgery" by Jones and Hey-Groves. This group of articles constitutes an admirable symposium on a difficult problem, one which still confronts the surgeon, both in military and civil hospitals and in every-day practice.

The immediate treatment of compound fractures, the disposition of bone fragments, the use of antiseptic solutions, the repair of infected fractures, methods of splinting, the treatment of osteomyelitis, of persistent sinuses, of deformities, the operative treatment of fractures, are ably discussed by men who bring a full and thoughtful experience to the solution of these problems.

Gibbon contributes a well written chapter on Surgical Technique which admirably describes débridement and antiseptic treatment of wounds, as developed through war experiences. Thorburn, in a brief chapter on spine and cord injuries, and in a second chapter on the treatment of peripheral nerve injuries, summarizes the results of war experiences in these particular fields. Matas contributes a well illustrated chapter on surgery of the blood vessels, in which he illuminates with experienced judgment the work achieved in this particular field during the war.

Volume VIII comprises a wide range of subjects, possibly of more definite interest to the surgeon in civil practice. Diseases of the thyroid gland are discussed from different standpoints in three separate chapters: from the standpoint of surgical treatment by C. H. Mayo, of pathology by Wilson, and of chemistry by Kendall. The latter two chapters are brief résumés of the work of these writers in specialized fields.

Surgery of the head is divided into separate chapters, the first on the hypophysis by Adson; the second, a general discussion of cranial surgery, including the treatment of gunshot wounds of the head, by Neuhof; the third and fourth, on trigeminal neuralgia and tumors of the gasserian ganglion, by Frazier.

Two well illustrated chapters on wounds of the face and jaws by Harte and Lee, and Darcissac, emphasize not only the importance and difficulty of the new problems that the war forced upon the attention of surgeons, and the progress that was made in meeting them, but also the importance of co-operation between the general surgeon and the dental surgeon in securing the best results.

The chapter on surgery of the lungs and pleura by Heuer is the longest in the volume, perhaps fittingly so, since the advances made in thoracic surgery during the war were more radical than those in any other specialized field of surgery. Though the reader cannot help but feel that the final word is yet to be spoken on many phases of the problem, he cannot but be impressed by the achievements of war surgeons in the difficult field of chest surgery.

Two chapters among those remaining, one on surgery of the bladder and ureters by Bransford Lewis and the second on surgery of the prostate by Young, deserve special mention, because of their completeness, and their admirable descriptions and illustrations of modern diagnostic and operative methods.

A well illustrated chapter on physiotherapy by McKenzie, a chapter on radium therapy by Duane and Greenough, on the use of the X-ray by Cole and Steiner, on electrodessication and electrocoagulation by Clark, are ample evidence of the completeness with which these supplementary volumes have covered the field of modern surgery. With the previously published volumes they stand as a splendid monument to the industry and ability of the illustrious editor.

S. L. KOCH.

[1] KEEN'S SURGERY, ITS PRINCIPLES AND PRACTICE. By various authors. Edited by William Williams Keen, M.D., LL.D. Vols. vii and viii and index. Philadelphia: W. B. Saunders Company, 1921.

AMERICAN COLLEGE OF SURGEONS

THE NINTH CONVOCATION OF THE AMERICAN COLLEGE OF SURGEONS; CONFERRING OF HONORARY FELLOWSHIPS IN THE ROYAL COLLEGE OF SURGEONS IN IRELAND

THE ninth Convocation of the American College of Surgeons was held in Philadelphia on October 28, 1921. Fellowships were conferred upon 721 candidates: 645 from the United States and possessions, 17 from Canada, 53 from South America, 3 from China, 1 from Korea, 1 from Syria, and 1 from the Bahrein Islands.

The Fellowship address was delivered by Sir Harold J. Stiles, K.B.E., Edinburgh, Scotland, and Honorary Fellowships were conferred upon Sir Harold J. Stiles, K.B.E., Edinburgh; Sir Robert Hy Woods, M.Ch.(Hon.), Past President, R.C.S.I., Dublin; Professor Hans Christian Jacobaeus, M.D., Stockholm; Professor Jean Frédéric de Quervain, M.D., Berne; Jan Schoemaker, M.D., The Hague; Miguel H. Alcivar, M.D., Guayaquil, Ecuador; Guillermo Gastañeta, M.D., Lima, Peru; João Alves de Lima, M.D., São Paulo, Brazil; José de Mendonça, M.D., Rio de Janeiro, Brazil; and Surgeon General Edward R. Stitt, United States Navy, Washington, D.C.

CONFERRING OF HONORARY FELLOWSHIPS IN THE ROYAL COLLEGE OF SURGEONS IN IRELAND

THE ceremony of conferring Honorary Fellowships in the Royal College of Surgeons in Ireland upon eight distinguished American Surgeons was an occasion of deep interest to all Fellows of the College who were present at the ninth Convocation.

The delegation from the Irish College consisted of Sir Robert Hy Woods, M.Ch. (Hon.), Past President, R.C.S.I., and Sir William Taylor, K.B.E., C.B., also a Past President, R.C.S.I. These distinguished guests of the American College were introduced by Dr. Harvey Cushing of Boston, who said:

"On March 2nd of 1784 a College of Surgeons came into the world, as was quite fitting, in a Maternity Hospital. This was none other than the famous Dublin Rotunda founded long before by Surgeon Bartholomew Moss, but the event of which I speak took place not in a ward but in the Board Room and by Royal proclamation.

"To the country of Jonathan Swift, of Oliver Goldsmith, and of Edmund Burke the world owes a great debt. But in medicine no less than in literature and public affairs have Irishmen stood high in the English-speaking world. The medical history of ancient Erin reaches back to times prehistoric, when Druids were priests and physicians. She had in Thomas Molyneux in the 17th century a figure likened to the English Sydenham, and the following years have produced Irishmen whose names are permanently enrolled among the leaders of our profession.

"Irish doctors have not always stayed in Ireland for their life's work, but the names of some of those who did we may recall in association with their great contributions. John Cheyne and hydrocephalus, Abraham Colles and 'Colles' Law,' Robert Adams and heart-block, Corrigan and aortic insufficiency,—but above all there stand out two figures, Robert Graves and William Stokes, to whom students the world over flocked for inspiration at their rounds in the old Meath Hospital, where they so long served as friends and colleagues.

"Surgery, physic, and midwifery were not so differentiated in their day as in ours, and so it is that such a one as Abraham Colles, twice President of the College and its Professor of Anatomy and Surgery, is no less famed for the law he established before the spirochete was discovered than for the description of the fracture with which his name is coupled on the lips of every medical student the world over.

"Another of the band of Irish surgeons who made Dublin famous in Colles' day was Sir Philip Crompton, four times President of the College between the years 1811 and 1856 and one of the founders of that unique organization, the Zoological Society of Dublin. Members of the medical profession have indeed always been prominent in the highly cultivated and select social circle for which Dublin, like Edinburgh, has been so celebrated.

"In the winter of 1917-18, the Base Hospital to which I was attached had as its neighbor in

Wimereux a hospital set up on the site where, 100 years before, Napoleon had gathered his legions for an invasion of England. This was No. 83 Dublin General Hospital, the Chief Surgeon and organizer of which was Colonel Sir William Taylor, then President of the Irish College; and we learned to love and respect him and the members of his Unit, not only for their personal qualities but for the stand they had taken in regard to the war. At that time, in May of 1918, there had been something over 1,000 persons holding degrees of the Irish College who had been in uniform; 35 of them had been killed in action or had died in service; 36 had received the Military Cross; 45 the Distinguished Service Order; and 173 had been 'mentioned in despatches.' I may give a single instance of what it may mean for an Irish doctor to be mentioned in despatches.

"'Captain Henry James Burke, R.A.M.C., for conspicuous gallantry on 8th November, 1915, near Turco Farm. A sergeant in the front line had his leg crushed by the blowing in of a dug-out, and Captain Burke found immediate amputation necessary. In order to save time he crawled across the open to get his instruments, while the enemy turned a machine-gun on him. In spite of their fire he returned the same way, and coolly performed the operation in the trench while the enemy were shelling it heavily'.

"Irishmen do not do things according to precedent. Chary of its honorary degrees, the Irish College, though it has been known to give its honors *in absentia*, has never before, so far as I am aware, sent delegates to another country to confer them. But these delegates should feel at home in a land to which, since the establishment of the colonies, the Irish have come in such shoals that now the largest ward of Dublin is in South Boston, and the County Mayo in the minds of many is identified with Rochester, Minnesota.

"Favored indeed may our own American College regard itself by the acts of friendship displayed, first by the Royal College of Surgeons of England in sending its President, Sir Rickman John Godlee, to our inaugural and by the gift from members of their College (representing the Consulting Surgeons of the Armies of Britain) of the beautiful mace before us which will always figure in our future ceremonies. Now come representatives from the still older Irish College to bestow their honors on a few of our Fellows as a mark of their good will to us all.

"It is my privilege, gentlemen, to introduce to you Sir William Taylor and Sir Robert Hy Woods, of the Royal College of Surgeons in Ireland."

Sir William Taylor presented the United States surgeons for Honorary Fellowship in the Royal College of Surgeons in Ireland as follows:

"It is an unspeakable delight to me to be here amongst you again and I shall long cherish the honor which has fallen to me to come here on this occasion. I now beg to propose that the President of the American College of Surgeons do leave the Chair temporarily, and that Sir Robert Woods, Acting President of the Royal College of Surgeons in Ireland, do take the Chair."

"Mr. President: It is only right and proper that nations which have a common inheritance in language, institutions, customs and sympathies, and which are actuated by the same high ideals of love of liberty, and of justice, should do honor to each other, and I do not believe there is a place on the habitable surface of the globe so appropriate for such a function, as that in which we are now engaged, as this City of Philadelphia.

"If I remember my Greek aright, Philadelphia is derived from two Greek words, φιλος and ἄδελφος which translated freely mean 'Brotherly Love.'

"The responsibility of my duty is great, but yet greater is the happiness that it has fallen to my lot, in these days of political and sectarian disputes in our country, to be able to speak of the unanimous and genuine pleasure that the intention, on the part of our College, of conferring these Honorary Fellowships, created throughout the length and breadth of the land.

"We trust that the honors now about to be conferred by us as the representatives of the Royal College of Surgeons in Ireland may be taken, not only as an appreciation on the part of the College of the distinguished services rendered by each of the recipients to the great advance in the science and art of surgery, and of the very exalted position they individually occupy in the profession, but, as a further evidence of our desire to perpetuate that friendship which was established between the members of the profession of your great nation and ours, in the recent war.

"Established in the year 1784 by Royal Charter, with two main objects in view, viz.: the improvement of medical education and the providing of a sufficient number of properly qualified surgeons for His Majesty's Navy and Army, the Royal College of Surgeons in Ireland has steadfastly endeavored to fulfill those two functions for which it was established, and I think it will be readily admitted that it has done so with commendable success.

"From time to time during the 137½ years of its existence, the President, Vice President, and Council of the College have exercised the right, given them by the Royal Charter, of conferring

the highest honor, viz., The Honorary Fellowship of the College, upon men of great distinction and eminence in the profession, and, on three occasions, upon men of eminence and distinction, not members of the profession, who did honor to the profession and helped to advance the cause of surgical science to some considerable extent.

"In conferring such honors, no doubt the College did honor to itself.

"That the College has by no means been lavish in the distribution of its honors is evidenced by the fact that in the 137½ years of its existence, we find only 69 names on its Honorary Roll.

"These names include such men of eminence and distinction as John Hunter, Percival Pott, Abernathy, Sir Astley Cooper, Sir Benjamin Brodie, Sir John Erichson, Helmholtz, Lord Lister, Pasteur, Sir James Paget, and John Shaw Billings, all of whom have passed away.

"There are but 13 Honorary Fellows now alive, of whom one is not a member of the profession, viz.: His Royal Highness, the Duke of Connaught, K.G., who, when he became Colonel-in-Chief of the Royal Army Medical Corps, was elected an Honorary Fellow. There are, therefore, ony 12 members of the medical profession who now possess the honor. Of these, three were directors of the Army Medical Service who did magnificent work for the profession in their department.

"That leaves 9 members of the surgical profession throughout the world who possess our Honorary Fellowship. Of these, two belong to the great American continent—Harvey Cushing, of Harvard, and Professor Cameron, of Toronto. We are now about to add 8 more distinguished names to our roll, thus making 21 Honorary Fellows, of whom nine will be citizens of the United States.

"In calling upon the distinguished surgeons whom we are to honor to come forward, I may say that I owe a deep debt of gratitude to the ancient Phœnicians and Greeks, who, when questions of precedence arose, which might lead to unpleasantness or diplomatic troubles, settled such questions by the use of the alphabet.

"I propose, therefore, to follow their wise example, and call up those, whom we are to honor, alphabetically: George E. Brewer, New York; George W. Crile, Cleveland; John M. T. Finney, Baltimore; Richard H. Harte, Philadelphia; William Williams Keen, Philadelphia; Charles H. Mayo, Rochester; William J. Mayo, Rochester; and Albert J. Ochsner, Chicago.

"These are all men who have never ceased to be students. They have always been learning while teaching, thus providing by their example that best of all teaching—the teaching how to learn—and showing, by their enthusiasm, the intense pleasure they derive from their search after truth.

"We respect them for their work. We rejoice in their success, and we now honor them for their worth. Men who have served their day and race as these men have all done, require no further eulogy from me to commend them to you.

"I pray you, therefore, Mr. President, confer upon them all the highest honor of the Royal College of Surgeons in Ireland."

The Honorary degrees were conferred by Sir Robert Hy Woods, acting for the President of the Irish College, Sir Edward H. Taylor, B.Ch., B.A.O., who, because of illness, was unable to come to America.

The closing remarks of the ceremony were delivered by Dr. W. W. Keen of Philadelphia, who is universally acknowledged as the dean of surgery. In thanking the Delegation from the Royal College of Surgeons in Ireland, Dr. Keen said:

"Twenty-one years ago, when the Royal College of Surgeons of England conferred the first Honorary Fellowships upon American surgeons, it was my privilege to respond for the Americans. I then said that, though your beloved Queen 'was not monarch of our persons, she was surely queen of our hearts.'

"Since that declaration, a new and deeper tie has bound us more closely than ever, and forever, to you. Two million American troops, even though so late, when you had borne the burden and heat of the conflict for three years, joined you as 'trustees for civilization' (with two million more training at home and pining to join them), and helped to give the *coup de grâce* to the German Army of Desolation. Thousands of our own boys lie beside your own dear ones 'in Flanders' Fields,' and in the sacred soil of France. Never can we forget this tie of blood brotherhood. 'A future breach in our peaceful and friendly relations,' as President Harding well declared but a few days ago, 'is unthinkable.'

"And now in Philadelphia, instead of in Dublin, an unexampled generous exception in your whole history since your charter was granted in 1784, you gentlemen, by order of the Royal College of Surgeons in Ireland, have conferred upon us the highest medical honor which you could bestow.

"As spokesman for my colleagues, I offer to you our sincere and heartfelt thanks, and request that you will convey this message to the College you so well represent."

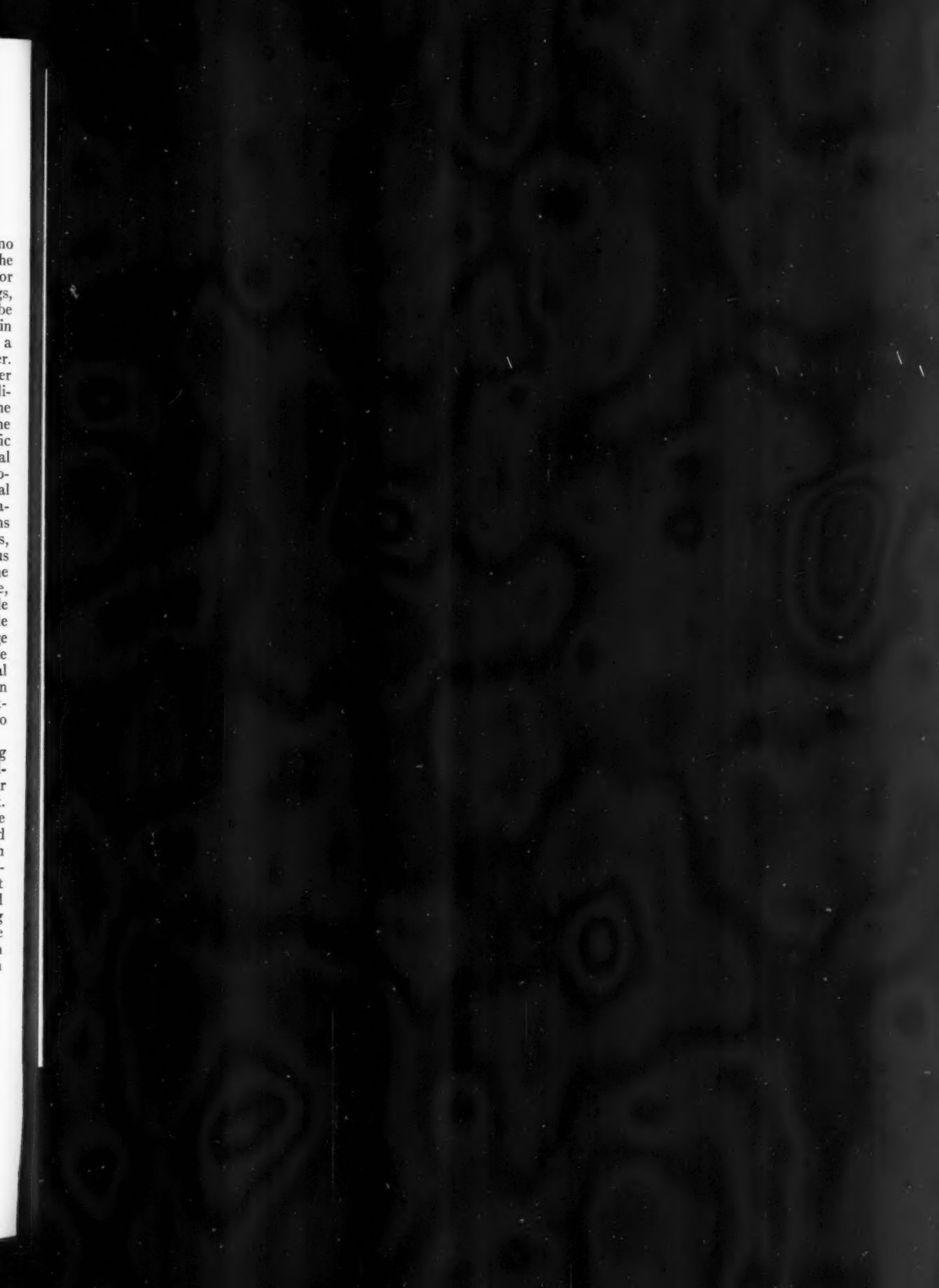
THE COLLEGE LIBRARY AND DEPARTMENT OF LITERARY RESEARCH

IN accordance with the action of the Board of Regents last June, the assembling of a large reference library is one of the very vital tasks before the Fellows of the College at the present time. A library built up by the Fellows of the College, for the Fellows of the College and the future members of the surgical profession of America, is bound to become a most complete and valuable collection of surgical literature. It cannot fail to grow rapidly. Such a library, to be representative of the best in American surgery, must contain the works of each and every member of the College. The Board has asked that each Fellow contribute autographed copies of books and reprints of articles written by him. In addition, it has requested him to send in a list of the books and journals, bound and unbound, which he is willing to donate or loan to the College from his private collection. The Board has also laid stress upon the collection of old works of historical interest.

Every effort is being made to obtain the cooperation of the medical publishers, other medical libraries, and the general medical profession throughout the country. Eighty medical journals and year books have already placed the College Library upon their complimentary mailing lists. Soon special funds and endowments will be forthcoming, it is hoped, for the purchase of various groups of books and for the completion of the journal files.

Already the requests have brought a sufficiently hearty response to overflow the available shelf space and to make the College feel the need of the new building, a portion of which may be especially devoted to a research library, with seminar rooms for intensive study, reading rooms, and suitable stack space.

Let the College set as its goal for the coming year the accumulation of a working reference library which will be of immediate service to each Fellow.

The Department of Literary Research will bring such a library within the reach of all the Fellows. Every effort will be made to meet the needs both of the surgeon in the large centers who is too busy to spend hours in a library and has no editorial department in his clinic, and of the pioneer surgeon in the outlying districts. For the latter, there will be special files of clippings, abstracts, and unbound journals, which may be loaned upon request. No pains will be spared in getting to him quickly the data needed on a difficult case or for the preparation of a paper. The Department will do for the Fellows, wherever they may be located, what the editorial or publication department of a large clinic does for the staff of that clinic. It will assist Fellows in the preparation and publication of their scientific books, papers, or lectures. It will prepare special bibliographies, collect material, and make abstracts and translations on any given surgical subject. Later this Department, like the publication department of a clinic, will assist commissions composed of Fellows, in the making of surveys, analyses, and statistical studies, based on various branches of the work of the Fellows. With the establishment of the library in the near future, it is hoped that the Department will be able through an endowment to render a reasonable amount of service to each Fellow of the College without cost to him. The need for such service is obvious. Only the largest clinics have editorial staffs. The high cost of literary assistance given by individuals in libraries or by any of the existing bureaus makes it absolutely prohibitive to the average surgeon.

The Department in the meantime is giving these various types of literary assistance to Fellows at a minimum cost, sufficient only to cover the actual expense of the individual piece of work. That the Fellows are glad to have such work done under the supervision of the College is evidenced by the number and variety of requests which have already been received. During the development of the College Library, the Department has the use of the already existing medical libraries in Chicago. The Department is making every effort to give the greatest service to the greatest number and eventually through an endowment to bring the service within the reach of all.